Alaska Habitat Management Guide

Impacts of Land and Water Use on Wildlife and Their Habitat and on Human Use of Fish and Wildlife

Produced by
State of Alaska Department of Fish and Game
Division of Habitat

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In addition, each species chapter is preceded by a matrix (table 1 of each chapter) depicting the impacts associated with each activity.

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Many individuals have been involved in the production of this volume. All products were reviewed first by project staff and distributed for a series of technical reviews. The names of reviewers and other contributors are compiled in appendix A.

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The process of developing the initial plan and procedures for this project involved a number of individuals who are not otherwise listed as authors and contributors. These include many of the staff within the Division of Habitat, as well as planners and research and management coordinators of other divisions. This group also includes all project team members and all ADF&G regional supervisors. Special mention should be made of the support from Alvin G. Ott, Lance Trasky, and Carl Yanagawa, Regional Supervisors of the Division of Habitat for the Interior-Arctic, Southwest, and Southcentral regions, respectively. Additionally, mention should be made of the contribution of Rai Behnert, who was the original coordinator of this project. We would also like to acknowledge the many contributions of John A. Clark, who was Director of the Division of Habitat until his death in 1985.

General Introduction

Overview of the Habitat Management Guides Project

Background

Alaska is an immense and bountiful frontier, and until recently it was almost inconceivable that we would ever need to worry about its capacity to sustain the wealth of fish and wildlife resources for which it is renowned. But the impetus of progress has not abated, and the pressure to develop our lands and waters intensifies daily. Every year more lands in Alaska are being proposed for uses other than as wildlife habitat, especially around cities, towns, and villages. These proposed uses include logging, mining, agriculture, settlement, and geothermal, oil and gas, and hydroelectric projects, among others. As the number of proposals and plans for development continues to increase, so does the need to carefully and efficiently evaluate their possible effects upon species and habitats, and upon human use of species. Once these evaluations have been completed we can recommend viable managerial options to guarantee that our valuable fish and wildlife resources and habitats, and uses of these fish and wildlife resources are adequately protected and maintained. By using appropriate planning and managerial techniques most of the potential for damage to fish and wildlife resources and loss of human use of these resources can be avoided.

One of the responsibilities of the Alaska Department of Fish and Game (ADF&G) is to assist land managers by recommending to them the best ways and means, based upon the best available data, for protecting fish and wildlife resources and human use of these resources against impacts. Because many proposals and plans for development and land uses require a rapid response from the department, there may not be enough time for staff to actually study the specific area in which the proposed development is to occur. However, the department still needs to accumulate and assess a wide variety of information in order to prepare recommendations for managing habitat. Therefore, the department initiated the Alaska Habitat Management Guides (AHMG) project to prepare reports of the kinds of information upon which its recommendations must be founded in order to responsibly and rapidly address land and water use proposals made by land managers.

Purpose

The Alaska Habitat Management Guides (AHMG) present the best available information on selected fish and wildlife species: mapping and discussing their geographical distribution; assessing their relative abundance; describing their life functions and habitat requirements; identifying the human uses made of them; describing their role in the state's economy; determining the impacts of human land uses and developments on these species; and developing guidelines to avoid or minimize such impacts.

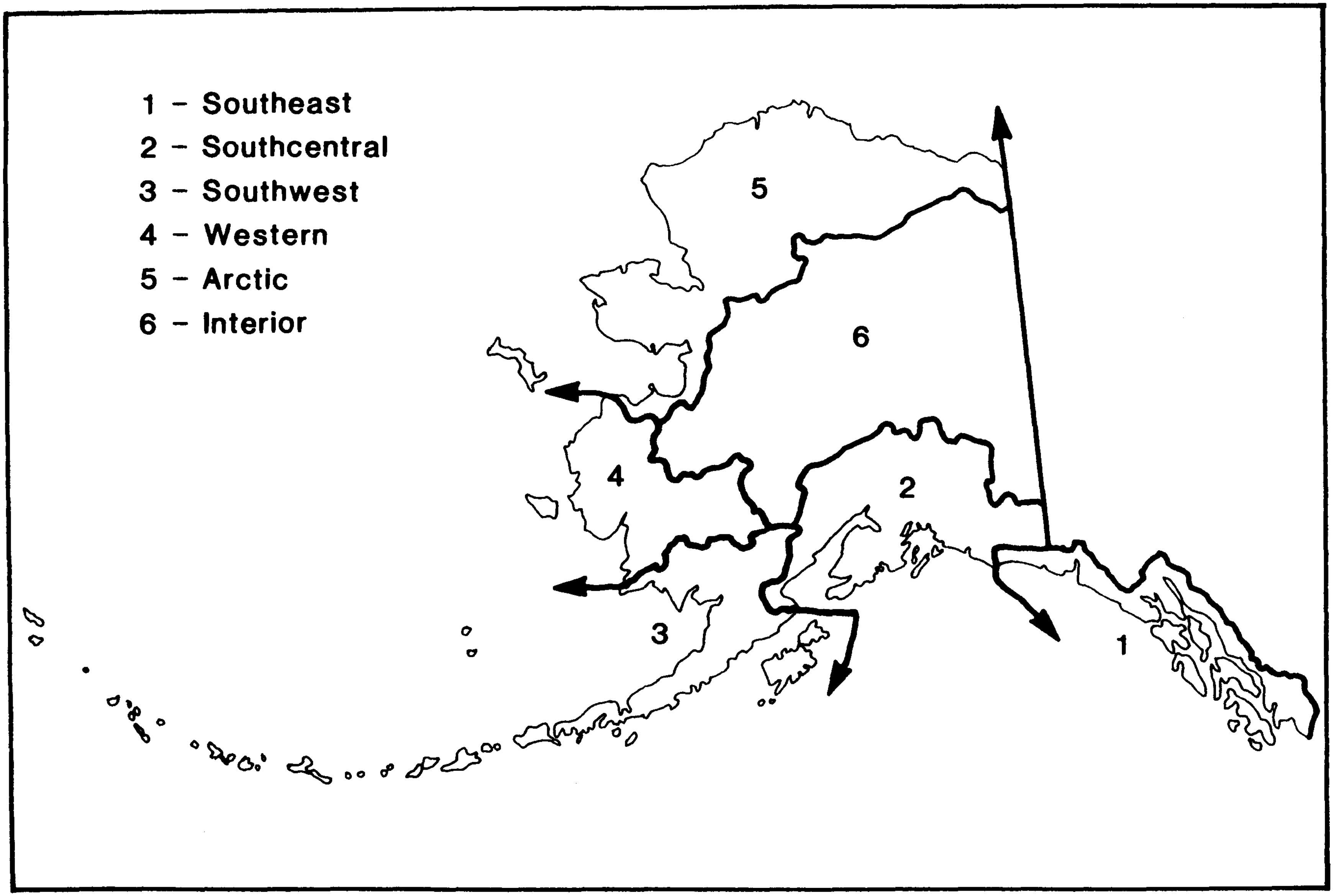
Essential to assessing what might happen to fish and wildlife if their habitats are altered is information about what impacts are typically associated with particular kinds of developmental activities. The habitat management guides therefore also provide summaries of these known impacts. This information, in conjunction with compiled species life history and distribution information, will allow those concerned to estimate to what degree fish and wildlife species and habitats are liable to be impacted and to develop recommendations for the avoidance or minimization of such impacts.

The completed guides coverage of fish and wildlife resources encompasses the Fish and Game Resource Management Regions established by the Joint Board of Fisheries and Game (map 1). These regions provide the most inclusive and consistent format for presenting information and fish and wildlife resources and relating it to management activities and data collection efforts within the department.

Applications

The choice of the term "guides" rather than "plans" for the reports is consistent with the largely advisory role of the department with respect to land management issues. The guides will provide the department as well as other state, federal, and private land managers with information necessary for the development of land and water use plans. Thus, the guides themselves are not land management plans, and neither do they provide for the allocation or enhancement of fish and wildlife populations. Information included in the guides will be used by the department's staff during their involvement in the land use planning endeavors of various land managers. For specific land use planning efforts, the department joins with other agencies to recommend particular uses of Alaska's lands and waters, as, for example, in plans by the Department of Natural Resources (Susitna Area Plan, Tanana Basin Area Plan, Southeast Tidelands Area Plan). The public, by means of the public review that is an integral part of land management agencies' planning processes, then has an opportunity to evaluate any recommendations made by the ADF&G that are incorporated by the land management agency.

The guides have been designed to provide users with interrelated subject areas that can be applied to specific questions regarding habitat management. Each type of data is presented in a separate volume, as indicated in figure 1. Material from the project's database can be used, for example, to correlate information on species' seasonal and geographic habitat use with the written and mapped information on known distribution and abundance. The narratives and maps regarding human uses of fish and wildlife can be compared with abundance and distribution information to obtain an indication of the overall regional patterns of distribution, abundance, and human use for the species of interest. The specific information on habitat requirements also relates directly to the information on impacts associated with land and water use. This in turn forms the basis for the preparation of habitat management guidelines.



Map 1. The six regions of the Alaska Habitat Management Guides.

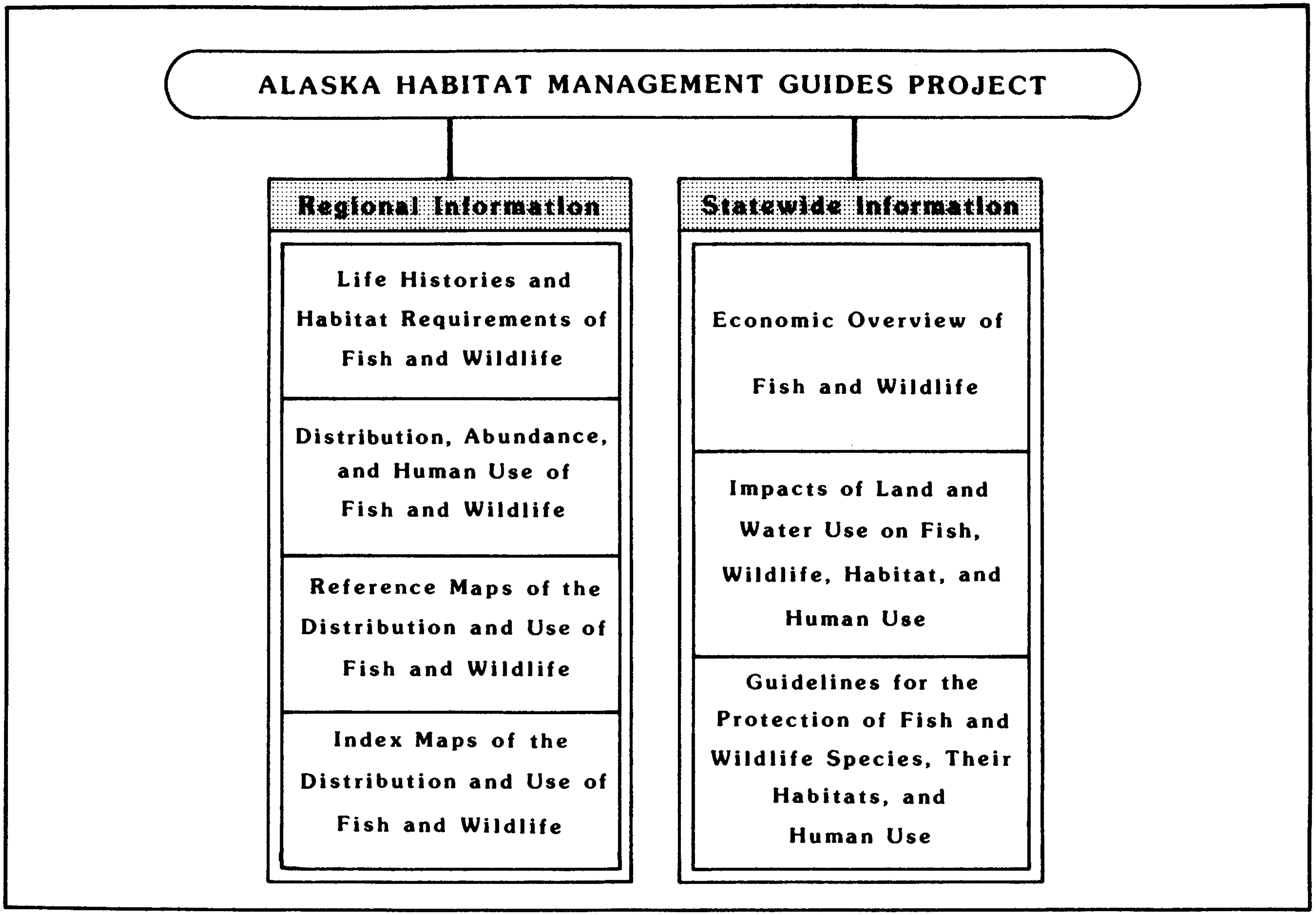


Figure 1. Types of narratives and maps produced by the Alaska Habitat Management Guides Project.

An additional purpose of this project is to identify gaps in the information available on species, human uses, and associated impacts. A particular species, for example, may be known to use certain habitats during certain seasons; yet information on the timing of these use patterns may be inadequate. In general, there is little documentation of impacts from land and water uses on species' habitats and on the human use of those species, or on the economic values associated with the use of fish and wildlife resources.

To maintain their usefulness these habitat management guides are designed to be periodically updated as new research and habitat management options are reported to fill data gaps. However, users of these guides are advised to consult with the appropriate species experts and area biologists to check on the availability of more recent information.

Introduction to This Volume

Purpose

A primary goal of the AHMG is to offer land management options for mitigating impacts to Alaska's fish and wildlife resources and their human use. Toward this goal, the present volume provides the best available information regarding documented impacts of land and water development and use on wildlife species and their habitats and on human use of fish and wildlife. Two companion volumes treat comparable information for fish species and their habitats. This information has been used to prepare the mitigation guidelines for habitat management that are compiled in the guidelines volume. The information presented here, in concert with information from the other AHMG volumes, can also be used to tailor recommendations to protect wildlife species and their habitat or human use of those species during the planning of a specific project.

Approach

For the purposes of this volume, the term "impact" is defined as an adverse alteration of a species' habitat or its use of habitat or of the human use of that species as a consequence of a human land or water use or type of development. The approach of including only documented impacts is a consequence of the recognition that in order to prevent further impacts, it is necessary to evaluate impacts that have already been shown to adversely affect a species or its human use. Several criteria have governed the selection of references to impacts that are discussed in this volume. Foremost among these criteria was that the referenced impact must have been objectively documented (i.e., observed) rather than merely suspected or inferred. Secondly, the conclusions regarding impacts must have been substantiated by the data presented. Thirdly, the impact described in the reference must be relevant to Alaska. To meet this latter criterion, the impact need not have occurred in the state provided that sufficient information was supplied in the literature to substantiate its relevance--that, for example, the impact affected a species or type of human use in a geographic locale having features similar to those in Alaska. The fourth criterion was that the impact must have been on a population or species or type of human use closely related to those featured in the AHMG. Thus, all references included in this volume have met specific criteria for documentation. References that were reviewed but did not meet these criteria--for example, suspected but not documented impacts--are on file with the department.

Organization of the Volume

The wildlife and human use impacts volume is organized into two major sections. The first section treats impacts of land uses and developments on wildlife species and their habitats. The second section treats impacts on human uses of fish and wildlife species. Each of these sections, in turn, is divided further into two portions: a "text" that provides citations to references for impacts to each featured species or type of human use, and an annotated bibliography of impacts references.

Eighteen land or water uses or development types (appendix B) were selected for discussion because they are currently important or are anticipated to become important in the state. Because entire development types or land uses are rarely incompatible with wildlife species or their human uses, each use has been divided into individual components called activities (table 1). For example, not all aspects of hay and grain farming (a land use) are responsible for impacts to wildlife; however, fencing (an activity) has been documented to cause impacts to certain species. A list of the activities and their definitions is provided in appendix C and appendix D, respectively. The advantages of separating each land or water use or development type into its component activities are numerous. Chief among these advantages is that activities that are most likely to cause impacts can be readily isolated, and can then be addressed in greater detail when a specific development project or proposal is presented. A second advantage is that activities that are common to several land uses or development types (e.g., transport of personnel by land) can be identified.

In order to focus the evaluation of impacts on species or their human use in relation to each activity, impacts have been organized into categories unique to wildlife (appendix E) and to human use (appendix F). The hierarchical relationship among uses, activities, and impact categories is depicted in figure 2.

User's Guide

Although the aim of this volume is to provide permitters or planners with the best available impacts information for the featured species and human uses, the volume is organized to provide not only several methods by which to arrive at this information but also the means to arrive at additional

Table 1. Activities Involved in Each Land or Water Use or Development Type

Land/Water Use \ Activity *	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land	Transport of oil/gas/water - water	Transport personnel/equipment/material - air	Transport personnel/equipment/material - land	Transport personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Commercial fishing														X		X					X	X							X	
Fire management		X		X	X							X		X							X	X	X	X			X	X		X
Geothermal energy development	X	X			X			X		X	X	X		X			X		X		X	X	X				X	X		X
Grain and hay farming		X	X	X	X	X			X	X	X	X		X					X		X	X	X	X			X	X		X
Harbors and shoreline structures	X	X	X		X		X	X		X	X	X		X					X		X	X	X			X	X	X	X	X
Offshore prospecting and mining	X						X	X		X				X					X		X	X				X	X	X	X	
Oil and gas development	X	X	X	X	X	X	X	X		X	X	X		X					X	X	X	X	X	X	X	X	X	X	X	X
Pipelines	X	X	X	X	X	X	X	X		X	X	X		X					X	X	X	X	X	X	X	X	X	X	X	X
Placer mining	X		X		X	X	X	X		X	X	X		X					X		X	X	X	X	X		X	X		X
Red meat and dairy farming		X	X	X	X	X			X	X	X	X	X	X					X		X	X	X	X			X	X		X
Seafood processing										X	X	X		X					X		X	X	X				X	X	X	X
Settlement	X	X	X	X	X	X		X		X	X	X		X					X		X	X	X	X	X	X	X	X		X
Silviculture and timber processing	X	X	X	X	X					X	X	X		X	X			X	X		X	X	X	X	X		X	X		X
Strip and open pit mining	X		X		X	X		X		X	X	X		X					X		X	X	X		X		X	X		X
Transmission corridors	X	X		X	X			X		X	X	X		X					X		X	X	X	X			X	X		
Transport - air, rail, road	X	X	X	X	X	X	X	X	X	X	X	X		X					X		X	X	X	X	X		X	X		X
Underground mining	X				X			X		X	X	X		X					X		X	X	X		X		X	X		X
Water development	X	X	X	X	X	X	X	X		X	X	X		X					X		X	X	X		X		X	X	X	X

* - For description of each activity, see appendices. Activities involved in road construction are discussed under each use for which roads are required.

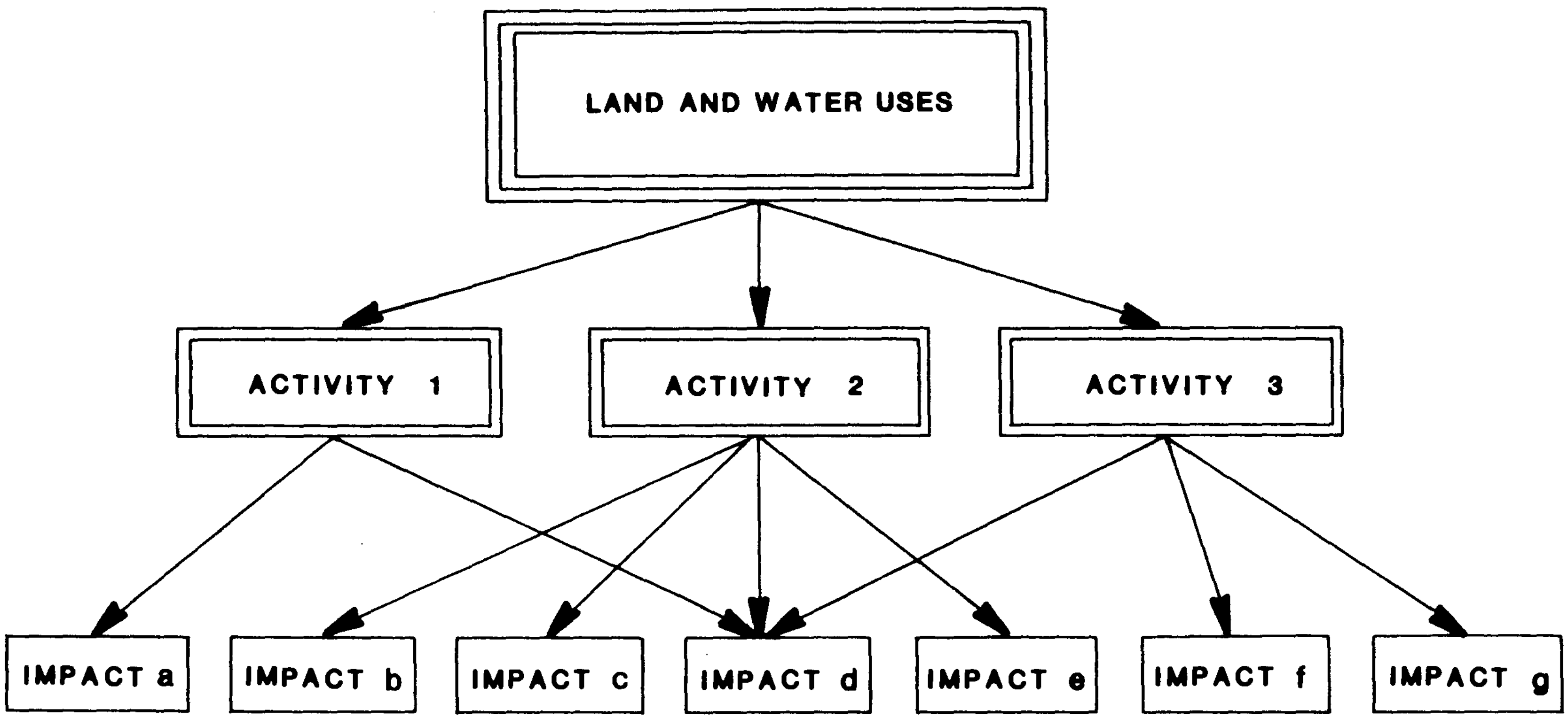


Figure 2. General hierarchical relationships of land and water uses, activities, and impacts.

information. The user may begin with several different types of information and arrive at the same conclusion. For example, if the user knows which species are present in the proposed area, s/he can turn directly to the individual species chapter. As another example, if the user is interested in finding out which activities for a proposed use cause impacts to the largest number of species or to human uses of wildlife resources, s/he can turn to table 2 of the wildlife introduction and to table 1 of the human use introduction.

Because we developed specific terms for activities, the user will need to be able to cross-reference other terms for these activities. A list of cross-references follows this section and is printed on yellow pages to facilitate access to our terminology and to the data presented for each species and for human use.

As a further explanation of how to use this volume, the user should consider the steps involved in determining the impacts to wildlife species as a result of a proposed project. We have therefore prepared the following hypothetical scenario to demonstrate the step-by-step use of this volume to arrive at the impacts information:

> A permitter in the Nome office receives a proposal to establish a plant to make plastic fishing floats in the Pah River valley. He is asked to prepare written comments on the likely impacts of that project on resident wildlife.

Assuming that the permitter may have little personal knowledge of the local wildlife, s/he would turn to this volume and to the Arctic guide and runs through the following steps:

1. S/he consults volume 2 of the Arctic guide to determine which featured species are present in the Pah River valley and volume 1 to determine if there are important life history functions that occur in that location.

2. After s/he determines the wildlife species complement in the Pah River valley, s/he turns to the General Introduction and to the introductions for the Wildlife and Human Use sections of this volume. After reading those sections carefully, s/he notes that there is no development type labelled "Plastics manufacture" in table 2 of the General Introduction. S/he then turns to the Cross-reference of Terms and discovers that impacts caused by plastics manufacturing is discussed under the activity of "processing of oil/gas." S/he also notes that there are related activities that may also impact wildlife in the Pah River valley.

3. S/he then looks at tables 2 and 3 of the Wildlife section to determine if there are any impacts on featured species in the Pah River valley that are caused by "processing of oil/gas" and related activities. S/he notes that there are documented and potential impacts to several

of the featured species, so s/he turns to the individual species chapters for citations for the documented impacts and reads the annotations to be sure that these impacts apply to this project.

4. If the permitter's mandate is to provide documented impacts information only, his/her job is completed. However, if the mandate is to provide all impacts information, s/he must use the species life history and distribution/abundance information, the potential impacts categories in tables 2 and 3 of the Wildlife introduction, and his/her own professional judgement to predict additional impacts.

In the second hypothetical scenario, we present a task that is not so common as the task in the first scenario but which uses the impacts volume for a slightly different purpose.

> The commissioner's office of the Department of Fish and Game receives a request from the legislature to provide proposed stipulations for a Dall sheep refuge in the Yukon delta. The stipulations are to cover the major land uses and development types likely to cause impacts to Dall sheep.

The staff person preparing the response uses the impacts volume, turns directly to the Dall sheep chapter, looks at table 1, and notes the activities that appear to cause the greatest number of impacts. S/he then realizes that many activities cause the same impacts; therefore, s/he turns to the organization of impacts by impacts category (rather than by activity) and prepares stipulations that address any activity that causes each impact. After completing stipulations that reflect documented impacts, s/he proceeds to prepare stipulations that reflect potential impacts.

Cross-reference of Activities for Impacts and Guidance

Agricultural runoff - see Chemical application

Agriculture - see Chemical application; Fencing; Grading/plowing; Grazing

Airguns - see Blasting

All-terrain vehicles - see Transport of personnel/equipment/material - land

Artificial islands - see Filling, aquatic

Bank Stabilization - see Channelizing Waterways

Borrow pits - see Dredging; Grading/plowing

Bridges - see Stream crossings - structures

Canals - see Channelizing waterways

Causeways - see Filling, aquatic

Chaining - see Clearing and tree harvest

Chemical storage - see Chemical application

Clearing

construction - see Clearing and tree harvest

right-of-way maintenance - see Transport of personnel/equipment/material - land, ice

Crossing streams - see Stream crossings - fords or structures

Culverts - see Stream Crossings-Structures

Dams - see Water regulation/withdrawal/irrigation

Defoliants - see Chemical application

Dikes - see Channelizing waterways

Disposal

Furfarming - see Grazing

Gathering lines - see Transport of oil/gas/water - land

Grain farming - see Chemical application; Fencing; Grading/plowing

Gravel excavating - see Dredging; Grading/plowing

Gravel washing - see Processing minerals

Harvesting trees - see Clearing and tree harvest

Herbicides - see Clearing and tree harvest

Hovercraft - see Transport of personnel/equipment/material - land

Hydroelectric dams - see Water regulation/withdrawal/irrigation

Ice drill pads - see Drilling

Ice roads- see Transport of personnel/equipment/material - land, ice

Icebreakers - see Transport of personnel/equipment/material - water

Insecticides - see Chemical application

Irrigation - see Water regulation/withdrawal/irrigation

Livestock - see Grazing

Logging - see Clearing and tree harvest; Log storage/transport

Low-water crossings - see Stream crossings - fords

Mining

concentrating - see Processing minerals

lode - see Blasting; Solid waste disposal

placer - see Dredging; Grading/plowing; Processing minerals

sluicing (gold) - see Processing minerals

smelting - see Processing minerals

strip or open pit - see Blasting; Dredging; Grading/plowing; Solid waste disposal; Processing minerals

Off-road vehicles - see Transport of personnel/equipment/material - land, ice

Oil tankers (rail) - see Transport of oil/gas/water - land, ice

Oil tankers (ships) - see Transport of oil/gas/water - water

Pesticides - see Chemical application

Phantom nets - see Netting

Pilings - see Filling and pile-supported structures

Pipelines (land) - see Transport of oil/gas/water - land

Pipelines (subsea) - see Transport of oil/gas/water - water

Plastics (manufacture) - see Processing oil/gas

Powerlines - see Transport of personnel/equipment/material - land

Pumping stations - Transport of oil/gas/water - land

Quarries - see Blasting; Grading/plowing; Processing of minerals

Railroads - see Transport of personnel/equipment/material - land

Ranching - see Fencing; Grazing

Refineries - see Processing oil/gas

Riprap placement - see Filling and pile-supported structures; Channelizing waterways

Road construction - see Grading/plowing

Road sanding/salting - see Chemical application

Runoff - refer to activity causing the runoff

Scraping - see Grading/plowing

Seismic exploration - see Blasting; Drilling

Settlements - see Human disturbance

Sluicing (gravel washing) - see Processing minerals

Spills

oil - see Processing oil/gas; Transport of oil/gas/water - land or water

chemicals - see Transport of personnel/equipment/material - air, land, water; Processing oil/gas; Processing minerals; Processing lumber/-kraft/pulp

Stream diversions - see Water regulation/withdrawal/irrigation

Surveying - see Clearing and tree harvest

Tailings - see Solid waste disposal

Telephone transmission lines - see Transport of personnel/equipment/material - land

Traffic - see Human disturbance; Transport of personnel/equipment/material - land

Tourists (on foot) - see Human disturbance

Tourists (in vehicles) - see Transport of personnel/equipment/material - air, land, water

Vibroseis - see Blasting

Wells

water - see Drilling; Water regulation/withdrawal/irrigation

petroleum, geothermal - see Drilling

Wildlife

Introduction

In the following section, the impacts of land or water use activities on featured wildlife species are discussed. The wildlife species featured in the AHMG and the regions for which impacts information applies are given in table 1. Two regions, Southeast and Southwest, are not directly discussed in this volume. Impacts to species featured in the Southwest Region were discussed in the first guide, the Alaska Habitat Management Guide--Southwest Region. After production of that first guide it was decided to separate the impacts volume from each of the regional habitat management guides and to present it as a separate, statewide volume. The Southeast Region has not been covered by a guide because of the limited number of land uses occurring there, because most of the region is federal land, and because the remaining state land has been the focus of recent planning efforts; therefore, a guide devoted to the Southeast Region would have largely duplicated existing planning efforts. However, impacts to several species that are inhabitants of the coastal portions of Southcentral Alaska (e.g., Sitka black-tailed deer, sea otter) are applicable to the same species in Southeast Alaska.

Species were featured for discussion in each region because of their importance to human use, their legal status (e.g., threatened or endangered), or because they represented a type of habitat that was common to many species. For example, moose are a featured species important not only because of their use by humans but also because they are representative of many species using riparian habitat. Therefore, guidelines prepared to protect moose would in all likelihood also protect numerous other species associated with riparian habitat. Although species were featured in each region, the impacts information gathered for those species may pertain equally to other regions; therefore the region(s) for which the impacts apply may pertain to more than one region or even statewide (table 1). Because available resources precluded treating more than these selected species, it is important to note that developments or land uses may create impacts to species other than those featured in this volume.

In the remainder of this section, wildlife species are arranged alphabetically as chapters within one of three broad categories--marine mammals, terrestrial mammals, and birds. Each chapter consists of a table providing a summary of those activities and their impacts that affect that species, a list of the references documenting each impact, and an annotated bibliography for that species. One species, caribou, is featured in the life history and distribution/abundance portions of each regional habitat management guide but is not discussed in this volume because two recent reports by the Division of Habitat, Technical Reports 86-2 and 86-3, have focussed specifically on impacts to caribou. These reports are included by reference as comprising the caribou impacts chapter.

Table 1. Featured Species and Regions for Which Impacts Apply

Species	Region: South-central	Arctic	Interior	Western	Statewide
Bald Eagle					x
Belukha whale		x		x	
Bowhead whale		x		x	
Brown bear					x
Caribou*					
Dall sheep					x
Ducks					x
Furbearers					x
Geese					x
Harbor seal	x				
Moose					x
Pacific walrus		x		x	
Polar bear		x		x	
Ringed seal		x		x	
Seabirds					x
Sea otter	x				
Sitka black-tailed deer	x				
Steller sea lion	x			x	
Trumpeter swan	x		x		

* Two reports have been prepared in lieu of discussion in this volume. For the complete reference to these reports, see chapter 10.

Because activities and impacts categories were selected on the basis of their relevance to a number or regions and wildlife species, not every individual activity or impact category applies to each species. For a quick reference to those activity and impacts categories that are not relevant to each species, see tables 2 and 3, respectively. For many species, there are relevant impacts for which no documentation was found; these are listed as potential impacts (table 3). A lack of documentation should not necessarily imply that impacts would not occur to that species; rather, the lack of documentation could be due to the fact that the opportunity for the impact to occur has not happened or that the impact has occurred but has not been documented in the literature.

Concerning impacts on wildlife habitat (e.g., wetlands), only those references were used that specifically described impacts to habitat and a featured species in the AHMG. Thus we did not use the large body of plant ecology literature that does not refer specifically to one of the featured wildlife species. This criterion was necessary under the constraints of time to complete this portion of the project.

Table 2. Activities that Cause Impacts to Featured Wildlife Species

Species	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Marine Mammals:																														
Belukha whale	X	#			#			X	#		#	#	#			X		?				#	#	#		X	X		X	#
Bowhead whale	X	#			#	#	X	X	#		#	#	#		#			#		X		#	#	#		X	X		X	#
Harbor seal	X	#		X	#			X	#				#	X		X				X			#	#		X	X	X	X	#
Pacific walrus	X	#			#				#		#		#	X	#			#					#	#	#		X	#	X	#
Polar bear		#			#	#			#		#	#	#	X	#			#				X	#	#	X	X		X		#
Ringed seal	X	#		X	#	#			#		#	#	#	X	#			#				#	#	#	X	X	X	X		#
Sea otter	X	#			#			X	#		#	#	#			X				X		#	#	#		X			X	#
Steller sea lion	X	#		X	#				#							X						X	#	#			X		X	#
Terrestrial Mammals:																														
Brown bear	X	X			X			X	X	#		X	X	X		#					X	X	#		X		X	X		
Dall sheep	X			X	X	#		X	X	#		X	X	X		#		#	X		X		#		X		X	X	#	X
Furbearers	X	X	X	X	X		X		X	X		X	X	X		#			X		X	X	?		X		X	X		X
Moose	X	X		X	X	X	X	X	X	X		X	X	X		#							#		X		X	X	X	X
Sitka black-tailed deer	X		X	X	X				X			X	X	X		#			X				#				X	X	X	X
Birds																														
Bald Eagle	X			X	X							X	X	X		?			X	X		X	#	#			X	X	X	X
Ducks		X		X	X	X		X		X		X	X	X		X			X	X	X	X	?		X	X	X	X	X	X
Geese	X			X	X			X		X		X	X	X						X			#		X		X	X	X	X
Seabirds	X			X									X	X		X			X	X	X	X	#	#	X	X	X		X	#
Trumpeter swan								X	X			X	X	X		#			X			X	#		X		X	X	X	

X - Documented impact
\# - Not relevant to this species
? - Potential impact

Table 3. Impacts to Featured Wildlife Species

Species	Aquatic substrate materials	Aquatic vegetation, destruction or change	Attraction to artificial food source	Barriers to movement, physical and behavioral	Collision with vehicles or structures	Entanglement in fishing nets, debris	Entrapment in impoundments or excavations	Harassment, active or passive	Harvest, change in level	Introduced wild/domestic species, competition	Morbidity/mortality by ingestion of petroleum	Parasitism/predation, increased susceptibility	Prey base, alteration of	Shock waves (increase in hydrostatic pressure)	Terrain alteration or destruction	Veg. composition, change to less preferred	Veg. damage/destruction due to air pollution	Veg. damage/destruction due to fire/parasitism	Veg. damage/destruction due to grazing	Veg. damage/destruction due to erosion	Water level or water quality fluctuations/
Marine Mammals:																					
Belukha whale	?	#		X	?	X		X			X			X	#	#	#	#	#	#	#
Bowhead whale	?	#	#		?		#	X		#	X	#		X	#	#	#	#	#	#	#
Harbor seal	?	#				X		X			X			X	#	#	#	#	#	#	#
Pacific walrus	?	#	#					X						X	#	#	#	#	#	#	#
Polar bear	#	#	X			#	#	X	X	#	X				#	#	#	#	#	#	#
Ringed seal	#	#	#		?			X	?		X			X	#	#	#	#	#	#	#
Sea otter	#					X		X			X			X	#	#	#	#	#	#	#
Steller sea lion		#	X			X		X	#		X			X	#	#	#	#	#	#	#
Terrestrial Mammals:																					
Brown bear			X	X	X			X	X	X			X		X	X		X	X	X	
Dall sheep	#	#	X	X	X	X	X	X	X	X		X	#	?	X	X		?	X	X	X
Furbearers	X	X	X	X	X	?	?	X	X	X	X	X	X		X	X		X	X	X	X
Moose	#		X	X	X	X	X	X	X	X		X	#	?	X	X	X	X	X	X	X
Sitka black-tailed deer	#	#	X	X	X	X	X	X	X	X	X	X	#	?		X	X		X	X	X
Birds																					
Bald Eagle	#	#	X	#	X	X		X			X			#					#	X	
Ducks		X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X
Geese			X	X	X	?		X			X	X	#	?	X	X				X	X
Seabirds			X		X	X	#	X		#	X	X		X	X				X		
Trumpeter swan			X		X	#		X			X	X	#								

X - Documented impact
\# - Not relevant to this species
? - Potential impact

1. Belukha Whale

Table 1. Impacts Associated With Each Activity - Belukha whale

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source	?		?	?			?	?		?				?					?	?	?	?			?	?	?	?	?	
Barriers to movement, physical and behavioral	?		?				?	?		?					?		?		?	?	?	?			?	?	?	?	X	
Collision with vehicles or structures			?				?	?		?					?		?		?	?					?	?		?	?	
Entanglement in fishing nets, debris							?	?		?					?	X	?		?			?				?			?	
Entrapment in impoundments or excavations	?		?				?										?													
Harassment, active or passive	X		?				?	X		?				?	?		?		?	?	?	?			?	?	X	?	X	
Harvest, change in level			?				?	?		?				?			?								?	?	?	?	?	
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum			?	?			?	?												?					?	X		?	?	
Parasitism/predation, increased susceptibility	?		?	?			?	?		?				?			?		?	?	?	?			?	?	?	?	?	
Prey base, alteration of	?		?	?			?	?		?				?			?		?	?	?	?			?	?	?	?	?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?		?	?			?	?		?																				
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

1. BELUKHA WHALE - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on belukha whale. Each citation refers to an annotation in the following section, Annotated References to Impacts on Belukha Whale. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to belukha whale are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to belukha whale were found for the following activities:

- Burning
- Channelizing waterways
- Chemical application
- Clearing and tree harvest
- Draining
- Dredging
- Fencing
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Grading/plowing
- Grazing
- Human disturbance
- Log storage/transport
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing minerals (including gravel)
- Processing oil/gas
- Sewage disposal
- Solid waste disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - land, ice
- Transport of personnel/equipment/material - land, ice
- Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

a. Harassment, active or passive

Goertner 1982
Hill 1978

b. Shock waves (increase in hydrostatic pressure)

Goertner 1982
Hill 1978

2. Drilling:

a. Harassment, active or passive

Gales 1982
Stewart et al. 1983

3. Netting:

a. Entanglement in fishing nets, debris

Frost et al. 1984

4. Transport of oil/gas/water - water:

a. Morbidity/mortality by ingestion of petroleum

Geraci and St. Aubin 1982

5. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Calkins 1983
Gales 1982

6. Transport of personnel/equipment/material - water:

a. Barriers to movement, physical and behavioral

Fraker 1977

b. Harassment, active or passive

Burns and Seaman 1985
Environmental Services LTD 1983
Fraker 1977

Gales 1982
Seaman et al. 1985
Stewart et al. 1983

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to belukha whale were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Collision with vehicles or structures
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Barriers to movement, physical and behavioral:

   a. Transport of personnel/equipment/material - water

      Fraker 1977

2. Entanglement in fishing nets, debris:

   a. Netting

      Frost et al. 1984

3. Harassment, active or passive:

   a. Blasting

      Goertner 1982
      Hill 1978

   b. Drilling

Gales 1982
Stewart et al. 1983

c. Transport of personnel/equipment/material - air

Calkins 1983
Gales 1982

d. Transport of personnel/equipment/material - water

Burns and Seaman 1985
Environmental Services LTD 1983
Fraker 1977
Gales 1982
Seaman et al. 1985
Stewart et al. 1983

4. Morbidity/mortality by ingestion of petroleum:

a. Transport of oil/gas/water - water

Geraci and St. Aubin 1982

5. Shock waves (increase in hydrostatic pressure):

a. Blasting

Goertner 1982
Hill 1978

ANNOTATED REFERENCES TO IMPACTS TO BELUKHA WHALES

The annotated bibliography contains only references that discuss documented impacts to belukha whales. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to belukha whales are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Burns, J.J., and G.A. Seaman. 1985. Biology and ecology. Part II in J.J. Burns, K.J. Frost, G.A. Seaman, and L.F. Lowry, prep. Investigations of belukha whales in coastal waters of western and northern Alaska. Final report of principal investigators (unpubl.). Environmental assessment of the Alaskan continental shelf, RU#612. USDC:NOAA, USDI:BLM. 129 pp. (ADFG-F)

This is a comprehensive report about the biology and ecology of belukha whales, and incorporates the authors' observations and results of field research as well as a review of the literature.

The discussion of impacts includes the effects of aircraft and boat traffic and other types of human disturbance on localized changes in belukha distribution and reactivity to sources of disturbance in the Chukchi and Bering seas, and a review of several references on documented and potential impacts of human activities. The original references from the latter discussion are also reviewed in this chapter.

Although the authors do not provide first-hand documentation of impacts they do present the current and historical observations of long-time coastal residents whom the authors believe to be knowledgeable. As such, these observations are included here although they rely on the interpretation of others. The authors note that coastal residents have observed that in the Norton and Kotzebue sounds, Kuskokwim Bay, and Yukon River delta belukhas have ceased using areas where they have been subjected to frequent active harassment by hunters in small boats, and to passive harassment by low-flying aircraft (not associated with hunting). Residents also have noted that belukhas have become more reactive to these sources of disturbance than they were in the past.

Activity: transportation of personnel/equipment/material - air, transportation of personnel/equipment/material - water

Impact: harassment, active (hazing, chasing) or passive (noise, scent)

Calkins, D. 1983. Marine mammals of Lower Cook Inlet and the potential for impact from Outer Continental Shelf oil and gas exploration, development, and transport. Pages 171-263 in Environmental assessment of the Alaskan continental shelf. Final reports of principal investigators. Vol. 20: Biological studies. USDC:NOAA. USDI:BLM. Anchorage. (HD)#

This report summarizes potential and documented impacts of oil and gas-related activities on marine mammals of lower Cook Inlet and Shelikof Straits area. Although most of the impacts that are discussed are potential rather than documented, the following documented impacts are presented:

(1) Oil pollution has caused morbidity and mortality in sea otters because of fouling of the otter's fur, upon which it relies to maintain thermoregulation.

(2) Oil pollution has also caused temporary blindness in grey seals (related to harbor seals), and damage to the eyes and kidneys of ringed seals (also related to harbor seals).

(3) Low-level flights by aircraft over harbor seal and Steller sea lion rookeries and haulouts have resulted in harassment. Animals have stampeded off the rookeries or haulouts; however, the responses varied with the environmental conditions (e.g., weather, sea state) as well as characteristics of the approaching aircraft.

The author also reported that a twin engine airplane flying 300 m (1,000 ft) above a group of belukha whales caused the animals to retreat to deep water.

(4) Human ground traffic (e.g., hikers, all-terrain vehicles) caused the abandonment of haulouts of Steller sea lion in California, and haulouts of harbor seals and Steller sea lions in another undisclosed location.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Environmental Services Ltd. (ESL). 1983. Ocean discharge criteria evaluation. Unpubl. rept. for Phoenix Marine Engineering, Daniels Creek dredging project, Alaska. 50 pp. (ADF&G-F, HD)#*

This document was prepared in support of a marine mining (dredging) project in Norton Sound. Several potential impacts were identified: (1) resuspension of mercury-laden sediments, and potential increase in bioaccumulation; (2) sedimentation of benthos; and (3) acoustic disturbance to marine mammals, especially belukha. The report concludes that impacts (1) and (2) would be minor in that they would be confined to a very small area. However, the report concludes that the noise from the dredging and support equipment may cause avoidance of a preferred feeding area of belukha (herring, capelin, cod and char are available). The report offers the following unreferenced statement about disturbance to belukha:

> "Noise has been reported to effect belukha whales up to 2 mi from dredges in shallow water (less than 6 ft). In deeper waters they [belukha] have been observed as close as 75 ft to moving barge tours. A high frequency of marine traffic movement caused interruption of [belukha] movements."

Activity: transport of personnel/equipment/material - water

Impact: harassment, active (hazing, chasing) or passive (noise, scent)

Fraker, M.A. 1977. The 1977 whale monitoring program, Mackenzie Estuary, N.W.T. Rept. for F.F. Slaney and Co., Ltd., to Imperial Oil Ltd., Calgary. 53 pp. (UAF)#*

This report presented observations on the biology of belukha and bowhead whales in the Mackenzie Estuary, and on the effects of offshore artificial gravel island construction on belukha movements and Innuit harvest activities. The report reaches the following conclusions:

(1) The mere physical presence of gravel islands does not disrupt whale movements or sonar functioning;

(2) Belukhas were observed to avoid important use areas during periods of intensive barge traffic, and to temporarily abandon areas when barges passed even as far as up to 4 km (1.5 mi) distance. The avoidance of barges by the belukhas persisted after the barge was out of audible range, suggesting that the bubbles left by the wake had a disruptive effect on the belukha's sonar;

3) Stationary drilling operations did not seem to disrupt belukha whale movements even when those activities were audible to belukhas as far away as 3.2 km (2 mi) for certain sounds and 1.6 km (1 mi) for the most common sound;

4) Belukhas were observed to travel within 400 m (1,200 ft) of an operating dredge during artificial island construction, but were observed to leave immediately when the support barge was started.

[Rev. note: conclusion nos. 3 and 4 were based on observations when belukhas were not concentrated in shallow nearshore areas where the effects of construction could be more severe (G.A. Seaman, pers. comm., ADF&G).]

Activity: transport of personnel/equipment/material - water

Impact: barriers to movement; harassment, active (chasing, hazing) or passive (noise, scent)

Frost, K.J., L.F. Lowry, and R.R. Nelson. 1984. Belukha whale studies in Bristol Bay, Alaska. Pages 187-200 in Proceeding of the workshop on biological interaction marine mammal and commercial fishing in the Southeast Bering Sea. Alaska Sea Grant Rept. 84-1. 300 pp. (UAF)*

This report provides the most comprehensive information to date on belukha distribution and movements in Bristol Bay. The report also documents cases of belukha deaths in the Kvichak and Nushagak Bays due to drowning after being entangled in nets. The number of such documented deaths has increased from none in the 1950's, to a minimum of 12 in 1983. This number is a minimum of 1% of the Bristol Bay summering group, and includes a greater number of calves than adults. In general, entanglement has been assumed to be in conjunction with the king salmon fishery only; however, it is now also associated with the red salmon fishery. Changes in gear type, increase in time gear is in water, and increase in the amount of setnetting in areas such as western Kvichak Bay, could be responsible for the increase in belukha entanglement.

Activity: netting

Impact: entanglement in nets or debris

Geraci, J.R., and D.J. St. Aubin. 1982. Study of the effects of oil on cetaceans. Final rept. to BLM, contract No. AA 551-CT9-29. 274 pp. (ADF&G-F, Habitat)

The effects of contact with and ingestion of crude oil and petroleum products on odontocetes and mysticetes were investigated in controlled experiments and some field observations. Topics investigated included the ability of cetaceans to avoid oil, the effects of petroleum products on cetacean skin, the effects of inhalation of petroleum vapors, effects of oil ingestion and bioaccumulation, and the effects of oil on baleen structure and function.

The authors' review of the literature and calculation of expected vapor concentration of specific hydrocarbons in the air above a crude-oil slick indicated that cetaceans stressed by lung and liver parasites or adrenal disorders would be particularly vulnerable to even low levels of hydrocarbon vapors. Animals away from the immediate spill area or exposed to oil that had weathered 2-4 h would be unlikely to suffer any consequences from inhalation.

No oil-ingestion studies were conducted; and, although no data on critical or lethal doses were found for marine mammals, from review of the literature and knowledge of cetaceans, the authors calculated the volumes of fuel oil some adult cetaceans would have to ingest to be at risk: harbor porpoise, 1.05 l; bottlenose dolphin, 3.0 l; killer whale, 75 l; and fin whale, 600 l. Although analysis of cetacean livers indicated that cetaceans should be able to detoxify some ingested oil, the effects of repeated ingestion of small amounts of oil (e.g., with or in food) are unknown.

Water flow through gray and fin whale baleen plates was monitored before and after contamination with three types of crude oil and Bunker C. Light-to-medium-weight oil caused transient changes; flow returned to normal within 40 s. Heavier oil restricted flow for up to 15 min and persisted on the baleen fibers for 15-20 h. Although exposure to gasoline, crude oil, and tar leached lipids and trace elements from baleen, no change in tensile strength of the baleen was found.

In a controlled situation, bottle nose dolphins could visually detect a 1-mm-thick film of dark crude oil and, using echolocation alone, could detect thick patches of oil (12 mm thick or greater). They also avoided experimental nontoxic oil slicks at first and, after a few contacts with the oil, avoided it completely for the remainder of that test and subsequent tests. Free-ranging gray whales reacted unpredictably to oil slicks from natural seeps along the California coast: many changed direction, swimming speed, and/or respiration pattern, but some showed no response.

Smooth cetacean skins exposed to crude oil and gasoline showed some discoloration, depression of phospholipid synthesis, and, occasionally, some damage to the mid and outer layers of skin, although wounds and damaged skin exposed to oil healed within 15 d. Although noted morphological changes were reversible even after 75 min exposures, "persistent biochemical changes (may) impair the functional integrity of the skin." Reviewers Note: cetaceans tested are smooth-skinned, bowhead skins are rougher.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Naval Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)#*

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-foot (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are of extrapolation from terrestrial mammals. The injury contours were developed for lung injuries and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two.

For example, if a 1,200 lb charge was exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-foot (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) would be, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales, and the depth and size of the explosion. Modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on effects of underwater explosions.

Activity: blasting

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. M.S. Inst. Ocean. Sci. Sidney, B.C. 50 pp. (ADF&G-F, Habitat)#*

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals, or to determine the effects which may be anticipated due to the blasting program when the specific design of that program is unknown.

Details are given for damage zone prediction using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries including level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries; animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting

Impact: harassment, active (chasing, hazing) or passive (noise, scent); shock waves

Seaman, G.A., K.J. Frost, and L.F. Lowry. 1985. Distribution, abundance, and movements of belukha whales in western and northern Alaska. Part I in J.J. Burns, K.J. Frost, G.A. Seaman, and L.L. Lowry, prep. Investigations of belukha whales in coastal waters of western and northern Alaska. Final report of principal investigators (unpubl.). Environmental assessment of the Alaska continental shelf, RU 612. USDC:NOAA, USDI:BLM. (UAF)*

In addition to providing an excellent summary of belukha seasonal distribution and movements along the western and northern coast, this report documents several instances in which increased human activity, mostly boat traffic, has influenced belukha movements. In Bristol Bay, there is a marked displacement of belukha from areas which they frequent in late spring and early summer. This displacement is due to the increase in boat traffic which accompanied the operating of the commercial fishing season in June. In another instance, the authors report that in Kotzebue Sound, the movements of belukha in recent times has changed markedly from those of historical (prior to the 1940's) times due to the advent of substantial use of outboard motors, generators, barge traffic and other activities associated with increased use of mechanization. In these areas, belukhas no longer move nearshore as much as they did formerly, and in some cases avoid areas of human activity almost entirely.

Activity: human disturbance, transport of personnel/equipment/material - water

Impact: harassment, active (chasing, hazing) or passive (noise, scent)

Stewart, B.S., F.T. Aubrey, and W.E. Evans. 1983. Belukha whale (Delphinapterus leucas) responses to industrial noise in Nushagak Bay, Alaska. Tech. Rept. 83-161. USDC, NOAA, Juneau. 21 pp. (ADF&G-F)*

In this field experiment study in the Bristol Bay region, the responses of free-ranging belukhas to playbacks of oil drilling rig noise were studied in June-July, 1983. Observations were made from an anchored boat, as belukhas travelled along the Snake River. Belukha behavioral responses that were measured included changes in ventilation rates and intervals, and changes in swimming speed or direction. Aerial surveys were also conducted in order to assess the numbers and distribution of belukhas in Nushagak Bay proper. Recordings of industrial noise were played continuously as belukhas approached to within several kilometers of the site (in order to test the effects of ongoing noise), or were turned on when belukhas approached the site (in order to test the effects of a sudden change in noise).

Results of these experiments documented temporary and moderate effects on belukha behavior, including increased ventilation rate, ventilation interval, and general activity--these effects were noted to occur at up to 1.5 km (1 mi) in one instance when the recording was turned on as the belukhas neared the site. Results were statistically significantly different from "normal" behavior in only one situation--when belukhas were moving downstream at a falling tide. In only one case did whales change swimming direction, and that was at a distance of 300-500 m (1,000-1,500 ft) from the boat. These results were compared with those obtained the previous year in Bristol Bay proper--there, belukhas were found among diesel-powered fishing and processor boats, and tended to remain longer at the surface and to rise higher out of the water when at the surface. [Rev. note: Although the authors did not specifically discuss this observation further, presumably their point is that in the open waters of the Bay, with its vast escape habitat, whales are more "relaxed" around these boats.] In contrast, in both Nushagak Bay proper and in the Snake River, the animals responded strongly with escape behavior to outboard motors.

The authors' final conclusion is that belukhas respond more strongly to sudden changes in acoustical stimuli than to ongoing and constant sources; however, under these field conditions these responses constituted only a minor form of passive harassment.

Activity: drilling, transport of personnel/equipment/material - water

Impact: harassment, active (hazing, chasing) or passive (noise, scent)

2. Bowhead Whale

Table 1. Impacts Associated With Each Activity - Bowhead whale

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source																														
Barriers to movement, physical and behavioral										?																				
Collision with vehicles or structures																														
Entanglement in fishing nets, debris																?														
Entrapment in impoundments or excavations																														
Harassment, active or passive	X						X	X		?				?			?			?							X		X	
Harvest, change in level																?														
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				?				X												X	?	?				X				
Parasitism/predation, increased susceptibility																														
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction																														
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

2. BOWHEAD WHALE - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on bowhead whale. Each citation refers to an annotation in the following section, Annotated References to Impacts on Bowhead Whale. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to bowhead whale are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to bowhead whale were found for the following activities:

Burning
Channelizing waterways
Chemical application
Clearing and tree harvest
Draining
Fencing
Filling and pile-supported structures (aquatic)
Filling (terrestrial)
Grading/plowing
Grazing
Human disturbance
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Sewage disposal
Solid waste disposal
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - land, ice
Transport of personnel/equipment/material - land, ice
Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

a. Harassment, active or passive

Fraker et al. 1981
Fraker et al. 1982
Goertner 1982
Hill 1978
Ljungblad et al. 1984
Ljungblad et al. 1985
Reeves et al. 1984
Richardson 1985
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

b. Shock waves (increase in hydrostatic pressure)

Goertner 1982
Hill 1978

2. Dredging:

a. Harassment, active or passive

Fraker et al. 1981
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

3. Drilling:

a. Harassment, active or passive

Fraker et al. 1981
Fraker et al. 1982
Gales 1982
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

b. Morbidity/mortality by ingestion of petroleum

Braithwaite 1980
Braithwaite 1983
Geraci and St. Aubin 1982

4. Processing oil/gas:

   a. Morbidity/mortality by ingestion of petroleum

      Braithwaite 1980
      Braithwaite 1983
      Geraci and St. Aubin 1982

5. Transport of oil/gas/water - water:

   a. Morbidity/mortality by ingestion of petroleum

      Braithwaite 1980
      Braithwaite 1983
      Geraci and St. Aubin 1982

6. Transport of personnel/equipment/material - air:

   a. Harassment, active or passive

      Brueggeman 1982
      Carroll and Smithhisler 1980
      Fraker et al. 1981
      Fraker et al. 1982
      Gales 1982
      Ljungblad et al. 1983
      Richardson et al. 1983
      Richardson et al. 1984a
      Richardson et al. 1984b
      Richardson et al. 1985a
      Richardson et al. 1985b
      Richardson et al. 1985c

7. Transport of personnel/equipment/material - water:

   a. Harassment, active or passive

      Carroll and Smithhisler 1980
      Fraker et al. 1981
      Fraker et al. 1982
      Gales 1982
      Richardson et al. 1983
      Richardson et al. 1984a
      Richardson et al. 1984b
      Richardson et al. 1985a
      Richardson et al. 1985b
      Richardson et al. 1985c

B. Organization by Impact

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to bowhead whale were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Harassment, active or passive:

a. Blasting

Fraker et al. 1981
Fraker et al. 1982
Goertner 1982
Hill 1978
Ljungblad et al. 1984
Ljungblad et al. 1985
Reeves et al. 1984
Richardson 1985
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

b. Dredging

Fraker et al. 1981
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

c. Drilling

Fraker et al. 1981
Fraker et al. 1982
Gales 1982
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

d. Transport of personnel/equipment/material - air

Brueggeman 1982
Carroll and Smithhisler 1980
Fraker et al. 1981
Fraker et al. 1982
Gales 1982
Ljungblad et al. 1983
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

e. Transport of personnel/equipment/material - water

Carroll and Smithhisler 1980
Fraker et al. 1981
Fraker et al. 1982
Gales 1982
Richardson et al. 1983
Richardson et al. 1984a
Richardson et al. 1984b
Richardson et al. 1985a
Richardson et al. 1985b
Richardson et al. 1985c

2. Morbidity/mortality by ingestion of petroleum:

a. Drilling

Braithwaite 1980
Braithwaite 1983

Geraci and St. Aubin 1982

b. Processing oil/gas

Braithwaite 1980
Braithwaite 1983
Geraci and St. Aubin 1982

c. Transport of oil/gas/water - water

Braithwaite 1980
Braithwaite 1983
Geraci and St. Aubin 1982

3. Shock waves (increase in hydrostatic pressure):

a. Blasting

Goertner 1982
Hill 1978

ANNOTATED REFERENCES TO IMPACTS TO BOWHEAD WHALES

The annotated bibliography contains only references that discuss documented impacts to bowhead whales. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to bowhead whales are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Braithwaite, L.F. 1980. Baleen plate fouling. Pages 471-492 in J. Kelley and G. Laurensen, eds. Investigation of the occurrence and behavior patterns of whales in the vicinity of the Beaufort lease area. Final rept. to BLM from NARL. (ADF&G-A, Habitat)

Laboratory experiments were begun in 1980 to determine the filtration rate and efficiency of bowhead whale baleen plates before and after exposure to Prudhoe Bay crude oil, diesel #1 and #2, gasoline, and oil-dispersant solutions. Preliminary results showed marked decrease in filtration efficiency with even slight fouling and near zero filtration with extreme fouling, but no numbers were given. (See Braithwaite (1983) for final experiment results.)

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Braithwaite, L.F. 1983. The effects of oil on the feeding mechanism of the bowhead whale. Final rept. to USDI, contract No. AA851-CTO-55. (ADF&G-A, Habitat)

Laboratory experiments were conducted in 1980 to determine the filtration rate and efficiency of bowhead whale baleen before and after fouling with a variety of petroleum products. The mean control filtration efficiency was 97.2% (1.03 standard deviation [S.D.]). Mean filtration efficiencies of baleen coated with 0.5 and 1.0 mm films of Prudhoe Bay crude with added Arcoflow were 91.28% (4.05 S.D., N = 21) and 90.44% (3.20 S.D., N = 13), not significantly different. When baleen was fouled with a 10-mm layer of the same oil, efficiency was reduced to 85.88% (6.16 S.D., N = 12).

Additional tests were run with diesel #2, crude oil without Arcoflow, and crude oil with various concentrations of Corexit (an oil spill dispersant), but sample sizes were too small to be tested statistically. Diesel apparently had little effect on filtering efficiency, and Corexit decreased but did not eliminate the effect of crude oil fouling. Crude oil matted and clumped the baleen hairs, changing the spacing in the evenly fringed filter of normal baleen. The maximum effect was noted about 4 h after fouling; after approximately 8 h, filtration efficiency began to increase slowly as the oil was washed off; efficiency was reduced somewhat for at least 30 d.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Brueggeman, J.J. 1982. Early spring distribution of bowhead whales in the Bering Sea. J. Wildl. Manage. 46:1,036-1,044. (UAF)

From March through April 1979, ship-based helicopter surveys were flown over the pack ice and polynyas of the northwestern Bering Sea near St. Lawrence and St. Matthew islands to investigate bowhead whale distribution. Observations produced the tentative conclusion that the activity of transporting personnel/equipment/material by air sometimes produced the documented direct impact of passive harassment, although the author stated that "Helicopter noise did not appear to affect the counts, since whales displayed an avoidance reaction in only 11% of 160 encounters." The number of avoidance reactions of whales to overflights at 150 m (500 ft) and 230 m (750 ft) were not significantly different. See Carroll and Smithhisler (1980), who found that, in spring, migrating bowheads sometimes made sounding dives in response to aircraft, especially helicopters, flying below 152 m (500 ft). Age and sex of bowheads sighted were not given.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Carroll, G.M., and J.R. Smithhisler. 1980. Observations of bowhead whales during spring migration. Mar. Fish. Rev. 42:80-85. (ADF&G-F, Game)

During April-June 1975-1978, NMFS biologists stationed at Pt. Hope and Pt. Barrow, Alaska, counted and noted the behavior of bowhead whales migrating through shore leads by maintaining a 24 h watch (weather and ice conditions permitting) from camps on landfast ice near the leads. Sounds made by aircraft, snowmobiles, and walking were heard via a hydrophone in the lead. Behavioral observations produced the tentative conclusion that the activity of transporting personnel/equipment/material by air sometimes produced the documented direct impact of passive harassment. Aircraft flying below 152 m (500 ft), particularly helicopters, sometimes appeared to cause bowheads to make a sounding dive. Walking or operating a snowmobile near the edge of the lead appeared to cause whales to avoid surfacing near the disturbance. See Brueggeman (1982), who found avoidance reaction to helicopters in 11% of 160 encounters in early spring at the ice front. The ages and sex of the whales observed were not given.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Fraker, M.A., C.R. Greene, and B. Wursig. 1981. Disturbance responses of bowheads and characteristics of waterborne noise. Pages 91-95 in W.J. Richardson, ed. Behavior, disturbance responses and feeding of bowhead whales in the Beaufort Sea, 1980. Unpubl. rept. by LGL, Bryan, TX for BLM, Washington, DC. 273 pp. (ADF&G-A, Habitat)

This study was based out of Tuktoyaktuk, NWT, Canada, in the summer of 1980. Noises from drilling, dredging, drillships, aircraft, surface vessels, and seismic explorations were recorded, analyzed, and the short-term behavioral response of bowheads to them noted. The specific water depths, sex, and age of the bowheads observed were not given for each observation.

The direct response of bowheads to boats was conclusively documented. At a range of 3.7 km (2.2 mi) from a 16-m (52-ft) boat with an idling motor, bowheads altered their surfacing pattern by decreasing their time at the surface and the number of blows per surfacing; an increasing variability in those characteristics was also observed. When boats 16 and 60 m (52 and 200 ft) in length approached to within 1 km (0.6 mi), the whales, in addition to the above responses, swam away from the boat and scattered.

Bowheads typically dove in response to a twin-engine, fixed-wing aircraft circling at 305 m (1,000 ft) or less but not when it circled at or above 457 m (1,500 ft).

Bowheads frequently were seen less than 5 km (3.1 mi) from a dredging operation at an artificial island under construction, occasionally 1.8 km (1 mi) from the operation, and one came within 16 m (52 ft) of a barge. Noise was well above ambient level and almost certainly audible to bowheads within 5 km (3.1 mi).

Seven bowheads observed within 13 km (8 mi) of an active seismic vessel (using airguns) displayed behavior similar to that of whales observed nearby on previous and succeeding days when no seismic noise was present.

See also Fraker et al. (1982), Richardson et al. (1983), and Richardson et al. (1984) for succeeding years' data.

Activity: blasting; dredging; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Fraker, M.A., W.J. Richardson, and B. Wursig. 1982. Disturbance responses of bowheads. Pages 145-248 in W.J. Richardson, ed. Behavior, disturbance responses and feeding of bowhead whales (Balaena mysticetus in the Beaufort Sea, 1980-81. Unpubl. rept. by LGL, Bryan TX, for BLM, Washington, DC. 456 pp. (ADF&G-A, Habitat)

Short-term behavioral responses of bowhead whales to activities associated wtih offshore oil and gas exploration and development in the Canadian Beaufort Sea were monitored by aerial survey during the summers of 1980 and 1981. Interim results were published in Fraker et al. (1981); additional data are summarized here. Habitat (e.g., water depth), sex, and age of the whales observed were not given for each observation.

Boats. On some occasions, bowheads reacted to boats by decreasing surface and dive times at a distance of 3-4 km (1.8-2.4 mi). When boats approached to within 1-3 km (0.6-1.8 mi), whales usually oriented away from the boat and, on closer approach, swam away from it and scattered. Whales directly in the boat's path initially tried to outrun it, then turned aside as it approached to within a few hundred meters, although some allowed approach to within 100 m (328 ft). The differences in whale responses did not seem to be attributable to the boat's size or the loudness of its noise. Whales usually swam 1-6 (0.6-3.6 mi) km from the boat, then milled about. No evidence was found that whales completely left an area because of boat disturbance, although the effect of frequent or continuous boat disturbance was not investigated.

Aircraft. Mean surface times were slightly reduced in response to a twin-engine fixed-wing aircraft (Islander) circling at 457 m (1,500 ft) relative to those when it circled at 610 m (2,000 ft), but respiration and dive times were apparently not affected. In general, reactions to circling fixed-wing aircraft were conspicuous at 305 m (1,000 ft), minor at 457 m (1,500 ft), and absent or undetectable at 610 m (2,000 ft).

Seismic. Bowheads were seen 6-8 km (3.6 - 4.8 mi) from a seismic ship firing 12 large sleeve-exploders. Surfacing and respiration behavior of bowheads at 13 and 8 km (7.8 and 4.8 mi) from the ship was similar to that at similar depths in the absence of seismic noise. Industry personnel reported whales 2-7 km (1.2-4.2 mi) from a seismic vessel using airguns. Sonobuoys showed that whales often continued to call in the presence of seismic noise.

During a controlled experiment with one airgun 5 km (3 mi) from bowheads in eschelon feeding formation, significantly reduced surface times, blows/surfacing, and calling rates were found. A second trial, at 3 km (1.8 mi), produced ambiguous behavioral responses; habituation to seismic noise was not ruled out.

Drillships. Bowheads were seen at 4, 8, and 15-20 km (2.4, 4.8, and 9-12 mi) from active drillships; industry personnel reported sightings at 0.2-5 km (0.1-3 mi) . Whales at 4, 8, and 15-20 km (2.4, 4.8, and 9-12 mi) were feeding, including eschelon feeding, and socializing in the presence of drillship noise detected by a sonobuoy. Surface time, blows/surfacing, and dive times were significantly longer for a group of whales 4 km (2.4 mi) away than for a group 15-20 km (9-12 mi) away from a drillship. No calls were heard from the socializing group seen 4 km (2.4 mi) from a drillship; socializing whales normally call frequently.

No additional data on whale reaction to dredging were gathered.

Activity: blasting; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gales, R.S. 1982. Effects of noise of offshore oil and gas operations on marine mammals, an introductory assessment. NOSC Tech. Rept. 844 (TR844). Vols. 1 and 2. 79 pp. + appendices (300 pp.). (ADF&G-A, Habitat)

The effects of noise from offshore oil production and exploration platforms on marine mammals were assessed by a literature review, field observations, and interviews with oil platform personnel off California, in the Atlantic, and in Cook Inlet, Alaska. Some platforms were much quieter than others, depending on design and equipment. The distances at which large whales can detect platforms were calculated for several different areas, conditions, and assumptions. Gales concluded that 1) activities on oil and gas platforms produce significant noise over a wide range of frequencies with highest level components below 100 Hz; 2) noise from platforms measured was less than that from cavitating propellers of supply boats; 3) using probable auditory detection ranges of mysicete whales and conditions representative of Lower Cook Inlet, the probable detection range of low frequency components of platform noise was calculated to be 3,500 yd (3.2 km); 4) platform noise is unlikely to interfere with marine mammal echolocation or with other acoustic communication except very close to the platform; and 5) whales either ignore or easily avoid platforms. Effects on animals with a different noise-exposure history (i.e., that have not been exposed to industrial noise much before) are not known.

Activity: drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Geraci, J.R., and D.J. St. Aubin. 1982. Study of the effects of oil on cetaceans. Final rept. to BLM, contract No. AA 551-CT9-29. 274 pp. (ADF&G-F, Habitat)

The effects of contact with and ingestion of crude oil and petroleum products on odontocetes and mysticetes were investigated in controlled experiments and some field observations. Topics investigated included the ability of cetaceans to avoid oil, the effects of petroleum products on cetacean skin, the effects of inhalation of petroleum vapors, effects of oil ingestion and bioaccumulation, and the effects of oil on baleen structure and function.

The authors' review of the literature and calculation of expected vapor concentration of specific hydrocarbons in the air above a crude-oil slick indicated that cetaceans stressed by lung and liver parasites or adrenal disorders would be particularly vulnerable to even low levels of hydrocarbon vapors. Animals away from the immediate spill area or exposed to oil that had weathered 2-4 h would be unlikely to suffer any consequences from inhalation.

No oil-ingestion studies were conducted; and, although no data on critical or lethal doses were found for marine mammals, from review of the literature and knowledge of cetaceans, the authors calculated the volumes of fuel oil some adult cetaceans would have to ingest to be at risk: harbor porpoise, 1.05 l; bottlenose dolphin, 3.0 l; killer whale, 75 l; and fin whale, 600 l. Although analysis of cetacean livers indicated that cetaceans should be able to detoxify some ingested oil, the effects of repeated ingestion of small amounts of oil (e.g., with or in food) are unknown.

Water flow through gray and fin whale baleen plates was monitored before and after contamination with three types of crude oil and Bunker C. Light-to-medium-weight oil caused transient changes; flow returned to normal within 40 s. Heavier oil restricted flow for up to 15 min and persisted on the baleen fibers for 15-20 h. Although exposure to gasoline, crude oil, and tar leached lipids and trace elements from baleen, no change in tensile strength of the baleen was found.

In a controlled situation, bottle nose dolphins could visually detect a 1-mm-thick film of dark crude oil and, using echolocation alone, could detect thick patches of oil (12 mm thick or greater). They also avoided experimental nontoxic oil slicks at first and, after a few contacts with the oil, avoided it completely for the remainder of that test and subsequent tests. Free-ranging gray whales reacted unpredictably to oil slicks from natural seeps along the California coast: many changed direction, swimming speed, and/or respiration pattern, but some showed no response.

Smooth cetacean skins exposed to crude oil and gasoline showed some discoloration, depression of phospholipid synthesis, and, occasionally, some damage to the mid and outer layers of skin, although wounds and damaged skin exposed to oil healed within 15 d. Although noted morphological changes were reversible even after 75 min exposures, "persistent biochemical changes (may) impair the functional integrity of the skin." Reviewers Note: cetaceans tested are smooth-skinned, bowhead skins are rougher.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Ljungblad, D.K., S.E. Moore, and D.R. Van Schoik. 1983. Aerial surveys of endangered whales in the Beaufort, eastern Chukchi, and northern Bering seas, 1982. NOSC Tech. Doc. No. 605. 382 pp. (ADF&G-A, Habitat)

Aerial surveys and acoustic recordings were made of bowhead whales from mid April through May and from mid July through mid October 1982 in the northern Bering, eastern Chukchi, and Beaufort seas. Survey results and observations of bowhead distribution, relative abundance, migration patterns, general behavior, and sound production for spring and fall seasons are given. Adult whales responded to overflights by a twin-engine fixed-wing aircraft at various altitudes (up to 600 m, 1,968 ft) by surfacing, blowing, diving, changing swimming speed and/or direction, or slapping their tails; calves swam toward, over, or under the cow; and, twice, groups containing a calf gathered around it. The percentage of whales responding to aircraft ranged from 97% (N = 105) in early August in deep water and heavy ice, when the average flight altitude was 280 m (920 ft), to 8% in late September, when whales were feeding in shallow, ice-free water, with the average flight altitude 320 m (1,050 ft). Flight altitudes, water depth, and the ages and sex of the whales observed were not given for each specific response incident.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Ljungblad, D.K., B. Wursig, S.L. Swartz, and J.M. Keene. 1985. Observation on the behavior of bowhead whales (Balaena mysticetus) in the presence of operating seismic exploration vessels in the Alaskan Beaufort Sea. Unpubl. Rept. No. MMS 85-0076, MMS, Anchorage, AK. 78 pp. (ADF&G F, Game) *

In autumn 1984, bowhead behavior near active seismic vessels was observed on four occasions from a circling twin-engine fixed-wing aircraft at an altitude of 457 m (1,500 ft) or greater. Vessels conducting full-scale seismic operations were guided toward bowheads under observation from the aircraft; bowheads responded at distances ranging from 3.5 km (2.1 mi) to 7.2 km (4.3 mi) with huddling, tail slaps, or moving away at moderate-to-fast speeds. No discernable behavioral changes took place during exposure to seismic sound at ranges of greater than 10 km (6 mi), with pronounced changes occurring once an active vessel approached to within 5 km (3 mi) of the whales. The experimental vessels all approached whales head on, however, and later analysis of the propagation pattern of sound from seismic vessels shows that sound levels may be higher abeam of the vessels than directly in front or behind. In water more that 40 m (132 ft) deep, significant behavioral changes were noted when the received levels of seismic sounds reached 142 to 164 dB re 1 uPa at ranges from 5-7 km (3-4.2 mi). Avoidance responses, including orientation and movement away from the vessel, took place at ranges of 3.5 -5.0 km (2.1-3.0 mi), with received sound levels ranging from 160-170 dB re 1 uPa. Postdisturbance observations showed that whales return to predisturbance behavior within 30-60 min of the end of the disturbance. Only one of the experiments was conducted in water less that 40 m (132 ft) deep, and the authors concluded that the results are not directly comparable. Responses due to the ship itself were not separated from those due to the seismic noise alone.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Ljungblad, D.K., B. Wursig, R.R. Reeves, J.T. Clarke, and C.R. Greene, Jr. 1984. Fall 1983 Beaufort Sea seismic monitoring and bowhead whale behavior studies. Unpubl. Rept. No. MMS 14-12-0001-29064, Anchorage, AK. 77 pp. + appendices. (ADF&G-F, Game)

Seismic vessels were monitored and bowhead whale behavior was observed from twin-engine aircraft in the western Beaufort Sea from 18 August to 30 September, 1983. Planned controlled experiments were not successfully completed because of heavy ice conditions. Whale behavior was observed for a total of 32.2 hr, 28.2 hr of which were on "undisturbed" whales (not in the presence of seismic sound). Behavioral data from disturbed whales were collected when active seismic vessels were 42, 54, and 57 km away from the whales. The number of blows per surfacing was significantly lower for potentially disturbed than for undisturbed whales. The blow interval was not quite significantly longer for disturbed whales; surface and dive times were not significantly different between the two types of whales. Thus, the authors documented a change in behavior due to seismic noise.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Reeves, R.R., D.K. Ljungblad, and J.T. Clarke. 1984. Bowhead whales and acoustic seismic surveys in the Beaufort Sea. Polar Record 22:271-280. (ADF&G-F, Game)

From 28 August through 4 October 1982, bowhead whale movements and behavior were monitored by aerial survey from Barrow to the Canadian border. Grid transects were flown near active seismic vessels to 1) detect whales, 2) observe behavior before and after seismic shooting, and 3) generally note whale numbers, behavior, and movements.

One possible response to the onset of seismic noise was seen. A vessel 33 km (19.8 mi) from 18 bowheads began shooting and continued for about an hour. During the shooting, 12-14 whales gathered into a tight group ("huddle"), surfacing and diving almost synchronously. In this one instance, whales were found to spend a significantly longer time at the surface when in the presence of seismic noise, contrary to Fraker et al. (1982). Huddling has also been seen in bowheads not exposed to seismic noise. The habitat (e.g., water depth), ages, and sex of the whales observed were not given.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J. 1985. Observations on the behavior of the bowhead whale, Balaena mysticetus, on the summering grounds in the Canadian Beaufort Sea while in the presence of operating seismic exploration vessels. Abstr. third conference on the biology of the bowhead whale, 21-23 January, 1985, Anchorage, AK. (ADF&G-F, Game)

On 21 occasions in 1980-1984 in the eastern Beaufort Sea, short-term behavioral reactions of bowheads to seismic noise from ships 6-99 km (3.6-59.4 mi) away were monitored from aircraft circling at 457 m (1,500 ft) or more (i.e., high enough to avoid significant aircraft disturbance of the whales). Controlled tests were also done with a single 40-cu-in airgun fired 0.2-5 km (0.12-3 mi) away (N = 5), and a seismic ship with an airgun array fired 1.5-7.5 km (0.9-4.5 mi) from whales (N = 1). Sonobuoys monitored bowhead calls and the noise to which the whales were exposed.

General bowhead activities were rarely, if ever, observed to be altered by noise from seismic vessels 6 km (3.6 mi) or more away, but surfacing-respiration-dive cycles changed slightly. Blow intervals were slightly longer, dives shorter, fewer blows per surfacing, less time at the surface, and more turns and predive flexes were seen in the presence of seismic noise, although the variability was great and the values overlapped those found in the absence of seismic noise.

In general, short-term behavioral reactions of bowheads to seismic noise are "surprisingly mild, considering the high intensity of the noise pulses." Bowhead responses to the seismic boat were similar to those expected from the close approach of any boat. Overt reactions seemed minor, but long-lasting effects on distribution, stress level, and/or whales' auditory systems are unknown. The habitat (e.g., water depth), ages, and sex of the whales see were not given for each observation.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., R.S. Wells and B. Wursig. 1983. Disturbance responses of bowheads, 1982. Pages 117-215 in W.J. Richardson, ed. Behavior, disturbance responses, and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1982. Unpubl. rept., LGL, Bryan TX to MMS, Reston, VA. 357 pp. (ADF&G-A, Habitat)

Aerial surveys, begun in 1980 in the eastern Beaufort Sea to monitor the short-term behavioral responses of bowhead whales to boat and aircraft traffic, seismic, drilling, and dredging noise, were continued in 1982. (See also Fraker et al. [1981, 1982] and Richardson et al. [1984a]). Habitat (e.g., water depth), ages, and sex of the bowheads seen were not given for each observation.

Boats. A group of whales, already in the presence of seismic noise, with a received noise level of 132 dB//1uPa-m was approached by a 13-m boat. The whales swam rapidly away as the boat approached to 2-3 km (1.2-1.8 mi).

Aircraft. New information included 1) two trials of circling at 457 m (1,500 ft) then descending to 305 m (1,000 ft), 2) a comparison of behavior observed from the aircraft and from a quiet, drifting boat, and 3) subjective interpretations of the reactions of whales to aircraft on other occasions. All supported the previous conclusion (Fraker et al. 1982) that reaction is conspicuous at 305 m (1,000 ft), occasional but not major at 457 m (1,500 ft), and undetectable at 610 m (2,000 ft).

Seismic. The only consistent response of bowheads to seismic noise is that they do not normally swim away from seismic vessels operating 6 km (3.6 mi) or more away. Detailed comparisons of the surfacing and respiration behaviors of whales in the presence and absence of seismic noise have shown inconsistent results; the effects detected by quantitative analysis were not conspicuous to observers. Peak levels of seismic sounds on three occasions when whales seemed to be affected by the noise were 17-34 dB lower than levels near seemingly undisturbed whales.

Drillships. Bowheads were seen 10-12 km (6-7.2 mi) from an active drill ship. There were no consistent indications of unusual behavior among whales observed within 20 km (12 mi) of drill ships. During experimental playbacks of drill-ship noise, bowheads appeared to move more consistently and rapidly away from the playback site than they had before the playbacks began; the rate of calling also decreased.

No new data were gathered on the effects of dredging on bowheads.

Activity: blasting; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., R.S. Wells, and B. Wursig. 1984a. Disturbance responses of bowheads, 1983. Pages 101-215 in W.J. Richardson, ed. Behavior, disturbance responses, and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1983. Unpubl. rept. from LGL, Bryan, TX to MMS, Reston, VA. 361 pp. (ADF&G-A, Habitat)

Studies of short-term behavioral responses of bowheads to disturbance from aircraft, boats, active seismic vessels and drill ships, and dredging operations were continued (see Richardson et al. [1983], Fraker et al. [1982], and Fraker et al. [1981] for data from other years.) In 1983, the following additional disturbance experiments were conducted: three aircraft, one boat, one airgun, three drilling noise playback, and one dredge noise playback. (See Richardson et al. [1985b, c] for a summary of the entire project's results.)

Activity: blasting; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., P. Norton, and C.R. Evans. 1984b. Distribution of bowheads and industrial activity, 1983. Pages 309-361 in W.J. Richardson, ed. Behavior, disturbance responses, and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1983. Unpubl. rept. from LGL, Bryan, TX to MMS, Reston, VA. 361 pp. (ADF&G-A, Habitat)

Richardson et al. (1984a) continued short-term behavioral observations of bowheads and disturbance; this paper investigated long-term displacement from the "industrial area" of the eastern Beaufort Sea. In 1983, as in 1982, most bowheads remained outside the main industrial area. (See Richardson et al. [1985b, c] for a summary of the entire project.)

Activity: blasting; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., M.A. Fraker, B. Wursig, and R.S. Wells. 1985a. Behavior of bowhead whales Balaena mysticetus summering in the Beaufort Sea: reactions to industrial activities. Biol. Conserv. 32(3):195-230. (UAF)

Bowhead behavior and underwater noise near real and simulated activities associated with offshore oil and gas exploration and production were compared with behavior of "presumably undisturbed" whales and associated underwater noises in late July-early September of 1980-1982 in the Canadian Beaufort Sea. Whales reacted often to fixed-wing aircraft approaching at 305 m (1,000 ft), infrequently at 457 m (1,500 ft), and reactions were not detected to aircraft at 610 m (2,000 ft). When boats approached to within 1-4 km (0.6-2.4 mi), surface/dive cycles became shorter. Whales swam away as the boat approached but stopped when it was a few kilometers beyond them; scattering persisted longer. Bowheads did not move away from active seismic vessels 6 km (3.6 mi), but subtle behavioral effects were suspected. Whales were found 4 km (2.4 mi) from drill ships and less than 1 km (0.6 mi) from a dredge, but avoidance reactions resulted from playback experiments. Generally, bowheads were fairly tolerant of ongoing noise from seismic exploration, dredging, and drilling but tended to react strongly to more quickly changing situations such as approaching boats, aircraft, or a brief playback experiment. Long-term changes in behavior resulting from continued disturbance are not discussed. The habitat (e.g., water depth), ages, and sex of the whales seen were not given for each observation.

Activity: blasting; dredging, drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., R.S. Wells, and B. Wursig. 1985b. Disturbance responses of bowheads, 1980-84. Pages 89-196 in W.J. Richardson, ed. Behavior, disturbance responses, and distribution of bowhead whales Balaena mysticetus in the eastern Beaufort Sea, 1980-84. Unpubl. rept. from LGL, Bryan, TX for MMS, Reston, VA. 306 pp. (ADF&G-F, Game)

This report summarizes observations of short-term bowhead whale behavioral changes near actual or simulated industrial activities in the Canadian Beaufort Sea in late July-early September of 1980-1984. (See Fraker et al [1981, 1982] and Richardson et al. [1983, 1984, 1985a] for previous reports.) Results are for whales older than calves.

Aircraft. Overt reactions to a twin-engine fixed-wing aircraft were sometimes conspicuous when it was below 457 m (1,500 ft), uncommon at 457 m (1,500 ft), and generally undetectable at or above 610 m (2,000 ft). The usual reaction was a hasty dive when the aircraft first approached, with little or no detectable effect thereafter. Reactions were most common in waters less than 15 m (50 ft) deep (where lateral proagation of aircraft noise is greatest). Richardson et al. conclude that one pass by a small aircraft at altitudes of 305 m (1,000 ft) or less would sometimes cause bowheads to dive and that continued circling at those altitudes would affect respiration by shortening blow intervals. Except in shallow nearshore areas, flights at 457 m (1,500 ft) or more have little effect. On five occasions, bowheads were observed before, during, and after a helicopter made a single overflight at 153 m (500 ft); the whales were underwater each time and no reactions were detected.

Boats. Bowheads reacted more strongly to the approach of boats than to any other industrial activity by swimming away rapidly as boats approached within 1-4 km (0.6-2.4 mi). Initially, they attempted to outrun the boat; they then turned aside or dove. Groups of whales scattered. Fleeing usually ceased shortly after the boat passed; scattering persisted longer. Boat disturbance experiments were conducted in water ranging in depth from 6 m to 160 m (19.7-524.8 ft); strength of response was not correlated with water depth.

Seismic vessels. Bowheads did not swim away from seismic ships 6-99 km (3.6-59.4 mi) away, but blow intervals were longer and dive durations shorter than for presumably undisturbed whales. Effects sometimes were noted at received noise levels below 160dB//1uPa. One controlled experiment with a seismic vessel showed that bowheads began to orient away from the noise at 7.5 km (4.5 mi) but that some continued apparent bottom feeding until the boat was 3 km (1.8 mi) away. Whales were displaced when the boat was about 2 km (1.2 mi) away, about the same reaction as that to conventional vessels. Bowheads moved away from one airgun fired from a quiet boat, showing that bowheads do react to seismic pulses alone. Whales were observed in water depths of 10 m to 1,370 m (32.8 ft to 4,494 ft); strength of response was not correlated to water depth. Whales continued to call with about the same frequency and types of calls in the presence of seismic noise as when undisturbed.

Drill ships. Bowheads were seen less than 5 km (3 mi) from active drillships. When exposed to similar levels of noise playback experiments, they tended to orient away from the playback site, their call rate decreased, and during one playback, their near-bottom feeding ceased. Dispersal was not as rapid or consistent as when a boat approached the whales. Playback experiments were conducted in water depths ranging from 12 m (38.4 ft) to 150 m (492 ft).

Dredges. Although bowheads were seen within 1-5 km (0.6-3 mi) of an active dredge, whales moved away from a dredge noise playback site on two of three occasions, one time stopping feeding and moving up to 2 km (1.2 mi) away even though the level of noise received by the whales was lower in the playback experiment. All observations were in fairly shallow water.

Activity: blasting; dredging; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richardson, W.J., R.A. Davis, C.R. Evans, and P. Norton. 1985c. Distribution of bowheads and industrial activity, 1980-84. Pages 255-306 in W.J. Richardson, ed. Behavior, disturbance responses, and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1980-84. Unpubl. rept. from LGL, Bryan, TX for MMS, Reston, VA. 306 pp.

Other sections of the main report of which this is a part describe undisturbed bowhead behavior, industrial noise levels, and characteristics and short-term behavioral changes in bowheads due to industrial disturbance. This section describes the long-term effects of industrial activities on bowheads as evidenced by their distribution in summering areas of the Canadian Beaufort Sea. From 1980 through 1982, bowhead distribution overlapped less and less with that in the main industrial area of the Mackenzie River delta, where drilling, dredging, island construction, intensive boat and helicopter traffic, and seismic exploration have occurred since 1976. Numbers of bowheads in the area increased slightly in 1983 and again in 1984, but most were near the edges of the industrial region, rather than in the central area where whales were abundant in 1980. Limited data from the same area from 1976-1979 indicated that whales were numerous in the central part of the industrial area in August of 1976 and 1977 but not in 1978 or 1979.

In 1980-1984, bowheads were often seen in areas of seismic exploration that occurred within and beyond the main industrial area and in areas where whales had been exposed to seismic noise the preceeding year; there was no evidence of avoidance of areas of previous exposure to seismic noise.

Bowhead distribution varied markedly from year to year within as well as outside the main industrial area. Availability of food may influence whale distribution as much or more than does industrial activity; more research is needed.

Activity: blasting; dredging; drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

3. Harbor Seal

Table 1. Impacts Associated With Each Activity - Harbor seal

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source	?		?	?			?	?		?									?	?	?	?				?		?	?	
Barriers to movement, physical and behavioral	?		?				?	?		?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Collision with vehicles or structures			?				?	?		?					?		?	?	?	?						?			?	
Entanglement in fishing nets, debris			?				?	?		?					?	X	?	?	?	?		?				?			?	
Entrapment in impoundments or excavations	?		?				?										?									?		?		
Harassment, active or passive	X		?				?	?		?				X	?		?	?	?	?	?	?			?	?	X	X	X	
Harvest, change in level			?				?	?		?				?	?										?	?	?	?	?	
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum			?	X			?	X												X					?	X	?	?	?	
Parasitism/predation, increased susceptibility	?		?	?			?	?		?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Prey base, alteration of	?		?	?			?	?		?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?		?				?																							
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

3. HARBOR SEAL - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on harbor seal. Each citation refers to an annotation in the following section, Annotated References to Impacts on Harbor Seal. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to harbor seal are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to harbor seal were found for the following activities:

Burning
Channelizing waterways
Clearing and tree harvest
Draining
Dredging
Fencing
Filling and pile-supported structures (aquatic)
Filling (terrestrial)
Grading/plowing
Grazing
Log storage/transport
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Sewage disposal
Solid waste disposal
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - land, ice
Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

Goertner 1982
Hazard 1977
Hill 1978

b. Shock waves (increase in hydrostatic pressure)

Goertner 1982
Hill 1978
Rausch 1973

2. Chemical application:

a. Morbidity/mortality by ingestion of petroleum

Anonymous 1980
Helle 1981
Helle et al. 1976a
Helle et al. 1976b

3. Drilling:

a. Morbidity/mortality by ingestion of petroleum

Calkins 1983
Davis and Anderson 1976
Engelhardt 1983
Engelhardt et al. 1977
Geraci and Smith 1976
Smith and Geraci 1975

4. Human disturbance:

a. Harassment, active or passive

Everitt and Beach 1982
Hazard 1977
Schneider and Payne 1983

5. Netting:

a. Entanglement in fishing nets, debris

Everitt and Beach 1982
Loughlin et al. 1983
Matkin and Fay 1980
Miller et al. 1983

6. Processing oil/gas:

   a. Morbidity/mortality by ingestion of petroleum

      Calkins 1983
      Davis and Anderson 1976
      Engelhardt 1983
      Engelhardt et al. 1977
      Geraci and Smith 1976
      Smith and Geraci 1975

7. Transport of oil/gas/water - water:

   a. Morbidity/mortality by ingestion of petroleum

      Calkins 1983
      Davis and Anderson 1976
      Engelhardt 1983
      Engelhardt et al. 1977
      Geraci and Smith 1976
      Smith and Geraci 1975

8. Transport of personnel/equipment/material - air:

   a. Harassment, active or passive

      Hazard 1977
      Johnson 1976
      Murphy and Hoover 1981
      Riseborough et al. 1980

9. Transport of personnel/equipment/material - land, ice:

   a. Harassment, active or passive

      Miller et al. 1983
      Riseborough et al. 1980
      Terhune 1985

10. Transport of personnel/equipment/material - water:

    a. Harassment, active or passive

       Brown and Mate 1983
       Everitt and Beach 1982
       Hazard 1977

Miller et al. 1983
Murphy and Hoover 1981
Riseborough et al. 1980
Roffe and Mate 1984
Terhune 1985

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to harbor seal were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Entanglement in fishing nets, debris:

a. Netting

Everitt and Beach 1982
Loughlin et al. 1983
Matkin and Fay 1980
Miller et al. 1983

a. Blasting

Goertner 1982
Hazard 1977
Hill 1978

b. Human disturbance

Everitt and Beach 1982
Hazard 1977
Schneider and Payne 1983

c. Transport of personnel/equipment/material - air

Hazard 1977
Johnson 1976
Murphy and Hoover 1981
Riseborough et al. 1980

d. Transport of personnel/equipment/material - land, ice

Miller et al. 1983
Riseborough et al. 1980
Terhune 1985

e. Transport of personnel/equipment/material - water

Brown and Mate 1983
Everitt and Beach 1982
Hazard 1977
Miller et al. 1983
Murphy and Hoover 1981
Riseborough et al. 1980
Roffe and Mate 1984
Terhune 1985

3. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Anonymous 1980
Helle 1981
Helle et al. 1976a
Helle et al. 1976b

b. Drilling

Calkins 1983
Davis and Anderson 1976
Engelhardt 1983
Engelhardt et al. 1977
Geraci and Smith 1976
Smith and Geraci 1975

c. Processing oil/gas

Calkins 1983
Davis and Anderson 1976
Engelhardt 1983
Engelhardt et al. 1977
Geraci and Smith 1976

Smith and Geraci 1975

d. Transport of oil/gas/water - water

Calkins 1983
Davis and Anderson 1976
Engelhardt 1983
Engelhardt et al. 1977
Geraci and Smith 1976
Smith and Geraci 1975

4. Shock waves (increase in hydrostatic pressure):

a. Blasting

Goertner 1982
Hill 1978
Rausch 1973

ANNOTATED REFERENCES TO IMPACTS TO HARBOR SEALS

The annotated bibliography contains only references that discuss documented impacts to harbor seals. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to harbor seals are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Anonymous. 1980. The case of Baltic seals. Ambio 9(3/4):182. (UAF)#

Serious recent declines of populations of ringed, gray, and harbor seals have been documented in the Baltic Sea. Studies of Baltic ringed seals have shown that PCB's are responsible for serious failures in reproductive rates for these populations compared to other ringed seal populations. PCB's caused post-implantation disruptions which resulted in abortion or resorption. Although elevated levels of DDT were also found, PCB is the apparent agent.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Brown, R.F., and B.R. Mate. 1983. Abundance, movements, and feeding habits of harbor seals, *Phoca vitulina*, at Netarts and Tillamook Bays, Oregon. Fish. Bull. 81(2):291-301. (UAF)

This report summarizes field research on harbor seals conducted between 1977 and 1981 at two bays along the Oregon coast. Seasonal distribution, abundance, food habits and predation rates were studied. Observations and conclusions relevant to impacts include:

(1) Seasonal peaks in abundance at haulout areas were at different times in Tillamook Bay compared to Netarts Bay. Peaks in haulout abundance at Netarts Bay appeared to coincide with the return of chum salmon in late fall. The peak of abundance of harbor seals hauling out at Tillamook Bay coincides with the pupping and molting period (in spring), and is due to the more favorable habitat available there as opposed to Netarts Bay.

(2) Factors affecting the selection of haulout areas for pupping/molting in Tillamook Bay included the large number of small channels isolated from boat disturbance.

(3) Although haulouts in Netarts Bay were used substantially less during pupping than those in Tillamook Bay, use of the haulouts in Netarts Bay (as in Tillamook Bay) during pupping confirmed that isolation from boat traffic was a factor.

[Rev. note: Although no quantitative data on boat traffic were presented, the observation of increased haulout abundance in the absence of boat traffic is evidence that boat traffic disturbance affects distribution.]

Activity: transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Calkins, D. 1983. Marine mammals of Lower Cook Inlet and the potential for impact from Outer Continental Shelf oil and gas exploration, development, and transport. Pages 171-263 in Environmental assessment of the Alaskan continental shelf. Final reports of principal investigators. Vol. 20: Biological studies. USDC:NOAA. USDI:BLM. Anchorage. (HD)#

This report summarizes potential and documented impacts of oil and gas-related activities on marine mammals of lower Cook Inlet and Shelikof Straits area. Although most of the impacts that are discussed are potential rather than documented, the following documented impacts are presented:

(1) Oil pollution has caused morbidity and mortality in sea otters because of fouling of the otter's fur, upon which it relies to maintain thermoregulation.

(2) Oil pollution has also caused temporary blindness in grey seals (related to harbor seals), and damage to the eyes and kidneys of ringed seals (also related to harbor seals).

(3) Low-level flights by aircraft over harbor seal and Steller sea lion rookeries and haulouts have resulted in harassment. Animals have stampeded off the rookeries or haulouts; however, the responses varied with the environmental conditions (e.g., weather, sea state) as well as characteristics of the approaching aircraft.

The author also reported that a twin engine airplane flying 300 m (1,000 ft) above a group of belukha whales caused the animals to retreat to deep water.

(4) Human ground traffic (e.g., hikers, all-terrain vehicles) caused the abandonment of haulouts of Steller sea lion in California, and haulouts of harbor seals and Steller sea lions in another undisclosed location.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Davis, J., and S. Anderson. 1976. Effects of oil pollution on breeding gray seals. Mar. Pollut. Bull. 7(6):115-118. (UAF)#

The authors reported on the effect of a crude oil spill on breeding gray seals (Halichoerus grypus) in Wales. Adults on the breeding beaches, and pups born in the early part of the season came into extensive contact with the oil. There were at least two documented cases of pups so heavily fouled by oil that they drowned. Oiled pups did have significantly lowered weights, but the effects of this on long-term survival were unknown. Oil fouling during molting inhibited the loss of the pup's coat to some degree, but the new coat emerged unfouled unless the pup contacted a fouled adult or fouled shed coats. This report summarizes an earlier study which reported that harbor seal (Phoca vitulina) pups whose coats became fouled with oil were found to have inflamed skin under the oil- fouled fur.

The authors conclude that there was little substantiated impact to the population as a whole. However, they emphasize that neither pups nor adults had ingested oil and that additional impacts would likely occur in situations in which oil was ingested.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4:199-217. (ADF&G-A, Habitat)*

This review article summarizes data from both case reports and investigations of actual oil spills as well as recent experimental evidence. Although mortality has been attributed to oil exposure at sea in case reports, the evidence has generally not been conclusive in defining the toxicity of petroleum to seals, sea otters or whales.

After exposure to oil, ringed seal pelage that had been completely coated cleaned itself after one day in sea water. Captive sea otters and polar bears greatly increased the grooming of their oil-fouled fur, ingesting oil that resulted in injury or death. Shortly after exposure, sea otters and ringed seals began quivering, probably as a result of neurotoxic volatile hydrocarbons. Oil residues were found primarily in the blubber and liver of ringed seals beginning two days after exposure to oil. In the three polar bears tested, kidney, brain and bone marrow carried the highest petroleum residue load; no residues were detected in the adipose tissue. Both polar bears and ringed seals have the capacity to clear hydrocarbons by urine and bile. Oiled polar bear pelt samples showed increased thermal conductance; oiled sea otters nearly doubled their metabolic rate; oiled ringed seals showed no decrease in core temperature, presumably because they rely on a blubber layer rather than their pelage for insulation.

In general, response of sea otters to petroleum exposure was primarily severe thermal and metabolic stress, often leading to death. Ringed seals showed "limited toxic response" including reversible eye irritation, and absorption and distribution of residues throughout tissues, but there were no major pathological effects. Two of three polar bears exposed to crude oil on sea water died. The third bear recovered fully but only after several months of treatment and care.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Engelhardt, F.R., J.G. Geraci, and T.G. Smith. 1977. Uptake and clearance of petroleum hydrocarbons in the ringed seal, Phoca hispida. J. Fish. Res. Bd. Can. 34:1143-1147. (ADF&G-A, Habitat)*

Six ringed seals were immersed in sea water holding pens at Brown's Harbor, NWT covered by a 1 cm (0.4 in) thick slick of Norman Wells crude oil for 24 h. Five other seals were fed fish containing oil at a dose of 5 ml oil per seal per day for 5 days. Ages of seals were not given. Tissues and body fluids for controls for both studies were taken from six seals shot near the capture site of the experimental seals (Cape Parry, NWT) and assumed to be uncontaminated with petroleum hydrocarbons. Ringed seals showed rapid absorption of hydrocarbons into body tissues and fluids when exposed both by immersion and ingestion. Relatively low but significant levels were found in tissue, blood, and plasma, but levels in the bile and urine were high and some renal tubular necrosis was seen, indicating these to be the routes of excretion.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Everitt, R.D., and R.J. Beach. 1982. Marine mammal-fishery interactions in Oregon and Washington: an overview. Pages 265-277 in K. Sabol, ed. Transactions forty-seventh North American wildlife and natural resources conference. Wildlife Management Institute: Washington,DC. 722 pp. (UAF)

The authors reviewed the interactions of marine mammals and the nearshore commercial and recreational fisheries of Washington and Oregon. Marine mammals were observed to affect fisheries by destroying gear (e.g., nets, line) and stealing or ruining fish caught in nets or on lines. Fisheries affected marine mammals by entangling them in gear and causing injury or death, and by harassing animals at rookeries and haulouts so that seals have abandoned rookeries or haulouts.

Entanglement in gear primarily affects harbor seals because they tend to haul out in nearshore and estuarine areas where much of the best commercial and recreational fishing also occurs. A few Steller sea lions have also been killed by the nearshore fishery, but most sea lions have been taken in the offshore fishery.

Several Washington harbor seal haulouts were abandoned several decades ago because of intense human harassment, especially that associated with bounty hunting which was legal at the time. Currently, although harbor seals are no longer hunted most large haulouts are located in areas remote from human disturbance.

Current research efforts towards mitigation of the impact of entanglement are oriented towards the development of nonlethal methods (e.g., acoustical scaring devices) for keeping seals and sea lions away from actively fishing boats.

Activity: human disturbance; netting; transport of personnel/equipment/material - water.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures; harassment, active (hazing, chasing) or passive (noise, scent).

Geraci, J.R., and T.G. Smith. 1976. Direct and indirect effects of oil on ringed seals (Phoca hispida) of the Beaufort Sea. J. Fish. Res. Bd. Can. 33:1976-1984. (UAF)*

In autumn 1974, six ringed seals captured near Brown's Harbor, NWT, were immersed in a seawater pool covered with a slick of Norman Wells crude oil for 24 hrs. Transient eye irritations, minor kidney and possible liver lesions were noted, but no permanent damage was observed. Three seals transported to the University of Guelph and immersed in oil-covered water all died within 71 min of immersion. Hematological studies indicate that death was due to the stress of captivity superimposed on the effects of the oil.

In March 1974, six white-coated (3-4 wk old) harp seal (Phoca groenlandica) pups were coated with crude oil on the Magdalen Islands. Harp seal pups were used because ringed seal pups were not available. Three other pups were used as controls, and all were later killed for internal examination. No significant changes in body temperature or deleterious effects were noted.

Five captive ringed seals were subjected to a cumulative dosage of 50 ml crude oil fed with their fish food. High dosage (75 ml) and low dosage (25 ml) of crude oil were fed to two groups of six harp seal pups. No significant lesions or behavioral changes were noted.

All experiments were only of acute effects; the authors recommend that studies on chronic effects be conducted.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Hazard, K.W. 1977? [rept. undated]. Report on a survey of habitat selection by harbor seals in Tenakee Inlet and Freshwater Bay, Chichagof Island, summer 1977. Pac. Northwest For. Range Exper. Stat. Rept. FS-PNW-1652. USDA:USFS, Juneau. 36 pp. (HD-Fairbanks).

This report summarizes field research on harbor seals conducted between June-August, 1977, on Chichagof Island, Alaska. [Rev. note: Although this research was conducted in Southeast Alaska, similar habitat exists in the Southcentral Region, thus the results can be extrapolated.] The seals used 5 major hauling grounds in the area during pupping, nursing, and molting. Pupping apparently occurred between May 15 and June 20; molting from August 5 to at least August 31. During the molt, seals spent more time out of the water, were more reluctant to enter the water when disturbed (e.g. permitted closer approaches by boats, tolerated louder noises), and more often returned to the haulouts after being disturbed.

The author observed that the frequency of group departures from a hauling ground near (1.5 km, 1 mi) a logging camp (Crab Bay) was greater than at other major haulouts, and that this haulout was closer to a human settlement than the other haulouts studied. The Crab Bay logging camp was established in summer 1977, and the establishment of the hauling ground preceded the establishment of the camp; therefore, it was too early to predict the effects of this proximity on subsequent use of the hauling ground. Of 19 "land flees" (all seals rushing into the water) observed at the Crab Bay haulout, 11 were due to human activities (including blasting, rifle shots, and approaches by boats and low-flying aircraft). Of 10 "land flees" observed at other haulouts, the stimulus was apparent for only 7, and "researcher's approach" was the only human-related activity that appeared to be a stimulus. [Rev. note: the author did not really define whether "land flee" is equivalent to a "panic response," therefore, these data are not directly comparable to Murphy and Hoover (1981) and Johnson (1976).] The author points out that the mother/pup separation due to "land flees" in small seal colonies such as the ones observed in this study may not be as severe (e.g. reunion may be more common) than in colonies numbering in the thousands, such as the one observed by Johnson (1976).

Activity: blasting; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Helle, E. 1981. Reproductive trends and occurrence of organochlorines and heavy metals in the Baltic seal populations. Unpubl. rept, Marine Environmental Quality Committee, International Council for the Exploration of the Sea, C.M. 1981/E:37. 13 pp. (ADF&G-F, Game)*

Tissues of ringed seals in the Baltic Sea were analyzed for levels of total DDT, mercury, selenium, cadmium, zinc, and chromium in relation to age, sex, and reproductive status of the female in 1974-1979. The season of collection was not given. The productivity of the Baltic seal stocks decreased sharply during the 1970's. Less than 25% of the sexually mature females reproduced normally in the Gulf of Bothnia (Baltic Sea) due to an increasing number of occlusions of the uterine tract. The same pathological change has been reported for grey seals and harbor seals. Both PCBs and total DDT levels in ringed seal tissues from the Gulf of Bothnia peaked in 1977. No statistical differences in levels were found between sexes or the reproductive categories of females in 1977-1978, although they were statistically different in 1974-1975. Mercury and selenium levels in the liver were higher in females than in males; no differences were noted between the sexes for cadmium, zinc, and chromium. The relationship between high levels of environmental toxins and reproductive failures in seal populations is "highly complex and organochlorines and heavy metals may have combined effects."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Helle, E.M., M. Olsson, and S. Jensen. 1976a. DDT and PCB levels and reproduction in ringed seal from the Bothnian Bay. Ambio 5:188-189. (ADF&G-F, Game)*

In October and November of 1973 and 1974, 40 sexually mature female ringed seals were collected from Bothnian Bay in the Baltic Sea. Only 27% were pregnant compared to a normal 80-90% in areas with low levels of pollution. Significantly higher levels of both DDT and PCB were found in the nonpregnant females compared with the pregnant females. In November, about 4 mo before the normal pupping season, about half of the nonpregnant females showed enlarged uteri and scars on the uterine wall indicating that implantation had occurred, followed by resorption or abortion. Similar reproductive disturbances have been reported for California sea lions with high levels of PCBs; the authors conclude that "it seems probable that PCB and not DDT substances are responsible for the perturbation of reproduction in seals."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Helle, E., M. Olsson, and S. Jensen. 1976b. PCB levels correlated with pathological changes in seal uteri. Ambio 5:261-263. (ADF&G-F, Game)*

In October and November 1975, 24 sexually mature males and 109 sexually mature females were collected from Bothnian Bay in the Baltic Sea. About 40% of the females showed pathological changes of the uterus. The uterine horns were closed by stenosis and occlusions, which prevented any passage from the ovary out through the horn and explained the low reproductive rate. Animals showing these changes had significantly higher levels of DDT and PCB than normal pregnant females. A significant positive correlation between DDT and PCB levels and age was found in the males but not in the females. The levels of DDT and PCB substances were somewhat lower in fetuses than in their mothers. The authors conclude, "It is strongly indicated that PCB is responsible for the reproductive failure of seals in the Baltic area."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Johnson, B. 1976. The effects of human disturbance on a population of harbor seals. Pages 422-431 in K.J. Frost, L.F. Lowry, and J.J. Burns. Final report of Beaufort Sea activities. Annual report of principal investigators. Environmental assessment of the Alaska continental shelf. USDC:NOAA, USDI:BLM. (UAF)*#

This report summarizes observations of the effects of natural and man-caused disturbances on hauled-out harbor seals on Tugidak Island. Because harbor seal pups are directly dependent on their mother for the first five weeks, the pups are especially sensitive to disturbance that may cause separation from their mother at this time. Most pup mortality is due to starvation resulting from separation between pup and mother. An important contribution to this report is an assessment of the degree and intensity of "natural" disturbances in order to compare "natural" effects with man-caused effects.

The author summarized the effects of man-caused disturbances on harbor seals as follows:

(1) Frequent disturbances in an area increases the wariness and reactivity of the harbor seals.
(2) Helicopters and large planes cause more disturbance than do small planes.
(3) The reaction of seals to aircraft at lower altitudes is stronger than their reaction to aircraft at higher altitudes.
(4) If all the seals at a haulout entered the water at least two hours elapsed before the seals would return to the beach, and they would not return to the same haulout.
(5) It was estimated that the moderate amount of airplane traffic visiting Tugidak Island in 1976 was responsible for the loss of 10% of that year's pup population.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Loughlin, T.R., L. Consiglieri, R.L. DeLong, and A.T. Actor. 1983. Incidental catch of marine mammals by foreign fishing vessels, 1978-81. Mar. Fish. Rev. 45(7-8-9):45-47. (UAF)

This report summarizes the incidental catch of marine mammals as observed by U.S. fishery observers aboard foreign (mostly Soviet and Japanese) fishing vessels within the U.S. 200 mile limit between 1978-1981. Of the total 298 marine mammals observed, 217 were dead and 81 were released alive. Northern sea lions comprised 90% of the incidental take; harbor seals comprised less than 1%. Most of the northern sea lions were not taken near rookeries. The authors attribute the high incidental take of the northern sea lions to the fact that sea lions have learned to follow fishing vessels to eat discarded fish offal, thus placing them in danger of being entangled in gear. This characteristic has also resulted in sea lions changing their pelagic distribution somewhat - prior to the 1960's, most sea lions in the Gulf of Alaska-Bering Sea remained within 18 km (15 mi) of shore. With the advent of an extensive offshore commercial fishery, however, the occurrence of sea lions near vessels far offshore is commonplace.

Groundfish trawlers account for most of the incidental take, although some immature sea lion, fur seals, and harbor seals are taken in herring and salmon gill nets.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Matkin, C.O., and F.H. Fay. 1980. Marine mammal - fishery interations on the Copper River and in Prince William Sound, Alaska, 1978. Report 78/07 to Marine Mammal Commission, Washington, D.C. 71pp. (abstract only) (HD)#

The rates of damage to netted fishes and to the nets themselves by marine mammals, and the rate of incidental catch of marine mammals were assessed in three salmon drift gill net fisheries through random sampling on the fishing grounds and by interview at dockside. Damages were most severe in the Copper River spring fishery where they were attributed mainly to Stellar sea lions and harbor seals. The latter accounted for most of the damages in the Coghill summer fishery and in the Copper-Bering River autumn fisheries. Approximately 1,000 marine mammals were killed in the process, half of which were harbor seals, 40% were sea lions, and the rest were sea otters and harbor and Dall porpoises. Damages tend to vary with size of catch, location, and time.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Miller, D.J., M.J. Herder, and J.P. Scholl. 1983. California marine mammal-fishery interaction study, 1979-1981. Rept. to NMFS by Southwest Fisheries Center, La Jolla, CA. Contract #79-ABC-00149. 233 pp. (ADFG-G, Fairbanks)

This field research study in California documented the losses of commercial and sport fish taken by marine mammals, and the injury and mortality of marine mammals caught in commercial and recreational fishing gear.

The largest number of marine mammals of species relevant to Alaska that were caught in a 2-yr period included 1,900 California sea lions and 117 harbor seals. There were no documented losses of northern sea lions, although they were present in the area. The most numerous losses of marine mammals occurred in the shark drift and gill net fishery where more than half of the California sea lion mortality occurred. Harbor seal mortality was a problem only with the ocean gill net fishery, where 100 seals were taken. Other types of fisheries appear to be little problem to harbor seals because the seals either avoid the gear, or the fishery occurs in areas farther offshore or otherwise away from harbor seal habitat.

The authors also report other observations of human-induced effects on harbor seals. In 1979, dogs killed over 20 newborn seal pups at a rookery near Cypress Point, Monterey County. Human disturbance at the Double Point haulout at Pt. Reyes National Seashore resulted in the NPS restricting human access to that area. An historically large haulout at Strawberry Spit in San Francisco Bay is not utilized during the day because of human disturbance by boat and pedestrian traffic. The few animals now using the haulout do so only at night-time high tide.

Most measures to reduce the number of sea lions and harbor seals taken during the fisheries have failed. Acoustical deterrents, either explosive or electronic, had not satisfactorily worked as of 1983. Closing fishing areas around haulouts is one possible mitigating measure, but likely would not work in California where the best fishing grounds coincide with seal and sea lion haulouts.

Activity: netting; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures; harassment, active (hazing, chasing) or passive (noise, scent).

Murphy, E.C., and A.A. Hoover. 1981. Research study of the reactions of wildlife to boating activity along Kenai Fjords coastline. Final Rept. to Nat. Park Serv., USDI, by AK Coop. Park Stud. Unit, Univ. Alaska, Fairbanks. x + 125 pp. (UAF)*

This report presents results of field studies between May and August 1979 and 1980 on harbor seals (Phoca vitulina) and glaucous-winged gulls (Larus glaucescens) primarily in Aialik Bay on the Kenai Peninsula. Distribution, abundance, habitat utilization, and responses to human activity (aircraft and boating) were studied. The predominant characteristic of Aialik Bay harbor seal habitat utilization is that large (1-7 m diameter) icebergs from the Aialik Glacier are the preferred haulout habitat, especially where a large number of these bergs are rafted together. Bergs are especially used during pupping and molting, although during molting (July-August) the area is used mostly by juveniles. Because the mother/pup bond is relatively weak shortly after pupping, and because harbor seals give birth on the drifting bergs, disturbance during this period can be especially harmful. Two incidents of probable abandonment of pups by their mothers were observed. In addition, higher pup mortality was noted in 1979 when an unusual period of northeasterly wind blew the ice out of the bay and many pups were unable to haul out on the rocks. Increased distress vocalization by pups less than a week old was noted by the observers, and likely corresponded to increased abandonment. These incidents reinforce the importance of minimizing disturbance during pupping.

The authors noted responses of seals to three sources of disturbance - boats less than 6 m (18 ft) in length, boats greater than 6 m (18 ft) in length, and aircraft. In general, females with young pups were more reluctant to leave the bergs [Rev. note: although the authors attribute this to decreased "wariness," it was more likely due to a reluctance of the female to leave the pup on the berg] than juveniles and adults without pups. Only a small proportion (less than 2%) of the reactions were "panic" responses.

Factors which affected responsiveness to disturbance included density of the group, ice conditions, and factors associated with the disturbance source (e.g. motor size, speed of approach). "Low" [Rev. note: "low" and "high" density were not defined] density groups were more reactive - i.e. seals left the berg when the boat was farther away - than "high" density groups. During poor ice conditions - i.e., lower number of optimally-sized bergs available - females with pups were less likely to leave the bergs than during good ice conditions. The noise levels associated with larger motors, higher speed of approach, and amount of human movement in the vessel were directly related to the amount of disturbance. Aircraft altitude was inversely correlated with disturbance - flights at less than 30 m (100 ft) elevation caused approximately 2/3 of the hauled-out seals to abandon bergs. Overflights at elevations higher than 75 m (250 ft) usually evoked mild or no response.

The authors suggested guidelines including the following:

- During pupping, boats should remain 100 m (300 ft) from parturient seals; at all other times remain at least 60 m (190 ft) from hauled-out seals;

- Boats should approach hauled-out seals slowly and with a minimum of on-board human movement;

- Aircraft should avoid flying over hauled-out seals, especially during pupping;

- If aircraft cannot avoid flying over hauled-out seals, the aircraft should maintain an elevation of at least 75 m (250 ft), and constant airspeed and direction.

  Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

  Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Rausch, R.L. 1983. Post mortem findings in some marine mammals and birds following the Canniken Test on Amchitka Island. Rept. by Arctic Health Research Center, Univ. Alaska-Fairbanks, for U.S. Atomic Energy Commission. 85 pp. (UAF)

This report discusses the effects of the underground nuclear test ("Canniken Test") detonated at Amchitka Island on 6 November 1971. Following the test, numerous dead and injured marine mammals and seabirds were found along the beach of the island. Four harbor seals and twelve sea otters were found that were in suitable condition for necropsy. Injuries to sea otters appeared to be from two sources: rocks falling from cliffs and injuring otters resting below, and a combination of over- and underpressures (hydrostatic pressure changes) resulting in rupture of lungs and other thoracic organs as well as damage to the central nervous system. Injuries and mortality of harbor seals appeared to be due only to hydrostatic changes.

Animals on the surface of the ocean appeared to escape severe injury, whereas animals underwater at the time of the blast were most susceptible. Overpressures of 200-300 psi were recorded within 5 km (3 mi) of the blast; overpressures of 100-200 psi were recorded in a zone an additional 3.5 km (2 mi) beyond the near zone.

Activity: blasting.

Impact: shock waves (increase in hydrostatic pressure).

Riseborough, R., D. Alcorn, S. Allen, V. Anderlini, L. Booren, R. deLong, L. Fancher, R. Jones, S. McGinnis, and T. Schmidt. 1980. Population biology of harbor seals in San Francisco Bay, California. Mar. Mamm. Comm. Rept. MMC-76/19. 67 pp. (UAF)#

In addition to summarizing various aspects of the San Francisco Bay harbor seal population, this report summarized some of the impacts of development, including a Standard Oil refinery, on the seals. Although San Francisco Bay is polluted, sources of pollution are decreasing. The harbor seal population does not appear to be affected by pollution. However, disturbance, especially at haulouts and rookeries, is of greater impact significance than pollution. During their study, the authors observed numerous instances of disturbance affecting harbor seals and noted that Charles Scammon in 1974 commented on sensitivity of the harbor seals to disturbance. The authors found that several haulouts had been abandoned since the 1960's and that others were now used only at night, when disturbance from human foot and boat traffic is at a minimum. Pleasure and fishing boat traffic, airplanes flying at elevations below 160 m (500 ft), and foot traffic all caused seals to leave the haulouts.

No significant evidence of premature births were found in the Bay area harbor seals, although evidence for other pinniped species along the California coast indicated that DDE, PCB's, or a combination of the two with a viral infection had caused an increase in premature births in the 1960's and 1970's.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Roffe, T.J., and B.R. Mate. 1984. Abundance and feeding habits of pinnipeds in the Rogue River, Oregon. J. Wildl. Manage. 48(4): 1262-1274. (UAF).

This report presents results from field research from 1976-78 on the feeding habits and seasonal abundance of northern sea lion, harbor seal, and California sea lion in the Rogue River, Oregon. This area is similar to coastal river systems in Southeast and Southcentral Alaska. Included in the report is the conclusion that seasonal abundance of harbor seals on river haulout sites was influenced not only by seasonal abundance of salmon, steelhead, and lamprey (seals' main prey species) but also by local boat traffic resulting from fishing and tourist activity. This boat traffic resulted in passive harassment (seals were scared into the water) which apparently further resulted in seals avoiding the area during the period of most intensive boat traffic (April to July/August), and in spite of seasonally high abundance of prey. Evidence to support this conclusion also included the fact that during the fall, when boat traffic and prey were at the lowest levels of the year, harbor seals abundance on the haulouts remained high.

The authors did not mention a similar impact on either sea lion species.

Activity: transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Schneider, D.C., and P.M. Payne. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. J. Mammal. 64(3):518-520. (UAF)

The factors influencing the haul-out behavior of harbor seals were studied in southeastern Massachusetts in the winters of 1978 and 1979. Environmental conditions (i.e., tide, wave intensity, air temperature, wind direction and velocity, cloud cover) and human disturbance were observed in relation to the number and timing of seals hauling out. The authors point out that seals in this area of Massachusetts use rocky outcroppings isolated from shore, whereas in areas more remote from settlements seals frequently use gravel beaches on the mainland. Statistical analysis of the correlation between hauling out and environmental and disturbance variables indicated that of the environmental conditions, tide was most highly correlated with hauling-out; however, human disturbance was the next most highly correlated [Rev. note: the source of the disturbance--e.g., boat traffic, air traffic--was not mentioned].

The authors also note that there were differences in the synchrony of use between areas with and without human disturbance. Use of these rocky "ledges" was synchronous--all seals hauled out or left at the same time. However, in uninhabited areas, seals do not haul out synchronously.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Smith, T.G., and J.R. Geraci. 1975. The effect of contact and ingestion of crude oil on ringed seals of the Beaufort Sea. Beaufort Sea Tech. Rept. No. 5. Beaufort Sea Project. Dept. of Environment, Canada. ii + 66 pp. (HD)

This report summarized field and laboratory research on the effects of crude oil on wild-caught adult ringed seals (Phoca hispida) and whitecoat harp seals (Phoca groenlandica) from Cape Parry and the Gulf of St. Lawrence, respectively. In the oil immersion studies, sufficient crude oil was introduced to the holding tanks containing seals to totally cover the surface with one c.m. of oil. The seals were observed then sacrificed to obtain tissue samples, and necropsied. In the oil ingestion studies, a very small amount of crude oil was introduced to the holding tanks in which seals had been acclimated. Follow up procedures were the same as for the immersion studies.

Relevant observations and conclusions include:

(1) In the field oil immersion studies: (a) the visible effects of crude oil on ringed seals were intense lacrimation, inflammation, and slight ulceration of the eyes. After exposure to the oil for 24 hours, the animals were removed to a clean water pen; within several days the physiological effects disappeared. (b) The physiological effects on ringed seals included histopathic and enzymatic evidence of kidney and liver damage, some of which was probably reversible [for acute episodes]. (c) For both harp seal pups and ringed seal adults, no changes in body temperature due to oil fouling of the hair were observed. However the harp seal pups were old enough to have an insulating blubber layer - neonatal pups without blubber would likely experience severe hypothermia. (d) No other effects were noted for the harp seal pups.

(2) In the laboratory immersion experiments, all subjects died within 2 hours of introduction of the oil to the tank. Necropsy results suggested that the animals died of stress resulting from a combination of experimental confinement and molting, possibly exacerbated by contact with oil. Geraci (1972)* has observed biochemical evidence of stress in molting harp seals.

(3) In the ringed seal oil ingestion study, there appeared to be no visible or physiological effects, due to the small amount probably ingested.

(4) The authors stress that the studies are suggestive of effects that would occur during contact with oil of only a short duration, such as during the ice-free period of summer. Prolonged contact, such as during the winter, when oil could be trapped under the ice, would likely result in much more severe effects. This could be especially severe during the pupping season when neonatal ringed and harp seal pups (which rely on their haircoat for insulation until a sufficient blubber layer is developed) would be constantly exposed to oil fouling.

(5) In a separate lab experiment, included as an appendix to this report, N.S. Øritsland, University of Oslo, concluded that, unexpectedly, crude oil did not significantly change the insulating value in air of ringed seal fur. This was attributed to the fact that the high viscosity of crude oil prevents it from severely matting down the hair. However, the dark crude oil did increase the solar heating of seal's skin due to absorption of long-wave solar radiation. These affects are important to the physiological status of seals, because during the molt, ringed seals spend a considerable amount of time hauled out. During the molt thermo regulation is a significant problem.

*Geraci, J.R. 1972. Hyponatremia and the need for dietary salt supplementation in captive pinnipeds. J. Amer. Vet. med. Assoc. 163:574-577.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Terhune, J.M. 1985. Scanning behavior of harbor seals on haul-out sites. J. Mamm. 66(2):392-395. (UAF)

In this field study of the scanning behavior [i.e., alert watching] of harbor seals in an area of New Brunswick near a large port, the author observed that harbor seals readily entered the water at the approach of humans in a boat or on foot. Furthermore, New Brunswick harbor seals, which are occasionally hunted, spend significantly less time resting and more readily enter the water when approached than do northern California harbor seals, which are not hunted. The author concludes that differences in the frequency and type of harassment by humans is responsible for the differences in behavior between seals in the two areas.

Activity: transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

4. Pacific Walrus

Table 1. Impacts Associated With Each Activity - Pacific walrus

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove			?			?	?	?											?	?	?	?			?	?		?	?	
Aquatic vegetation, destruction or change																														
Attraction to artificial food source																														
Barriers to movement, physical and behavioral	?		?				?	?		?				?			?		?	?	?				?	?	?	?	?	
Collision with vehicles or structures	?		?			?	?	?		?							?		?	?					?	?		?	?	
Entanglement in fishing nets, debris																?	?		?	?		?			?	?		?	?	
Entrapment in impoundments or excavations			?			?	?										?		?	?					?	?		?	?	
Harassment, active or passive	X		?			?	?	?		?				X			?		?	?		?			?	?	X	X	X	
Harvest, change in level				?			?	?						?			?		?	?					?	?	?	?	?	
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				?			?	?											?	?					?	?		?	?	
Parasitism/predation, increased susceptibility	?			?		?	?							?					?	?					?	?	?	?	?	
Prey base, alteration of	?		?	?		?	?	?						?			?		?	?	?					?			?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?		?				?			?									?	?					?			?		
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

4. PACIFIC WALRUS - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on Pacific walrus. Each citation refers to an annotation in the following section, Annotated References to Impacts on Pacific walrus. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to Pacific walrus are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to Pacific walrus were found for the following activities:

- Burning
- Channelizing waterways
- Chemical application
- Clearing and tree harvest
- Draining
- Dredging
- Drilling
- Fencing
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Grading/plowing
- Grazing
- Log storage/transport
- Netting
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing minerals (including gravel)
- Processing oil/gas
- Sewage disposal
- Solid waste disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - land, ice
- Transport of oil/gas/water - water
- Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Goertner 1982
      Hill 1978
      Hill 1978

   b. Shock waves (increase in hydrostatic pressure)

      Goertner 1982
      Hill 1978
      Hill 1978

2. Human disturbance:

   a. Harassment, active or passive

      Fay et al. 1984

3. Transport of personnel/equipment/material - air:

   a. Harassment, active or passive

      Davis and Thomson 1984
      Fay 1981
      Salter 1979
      Taggert and Zabel 1982
      Taggert and Zabel 1983
      Trasky 1984

4. Transport of personnel/equipment/material - land, ice:

   a. Harassment, active or passive

      Fay 1981

5. Transport of personnel/equipment/material - water:

   a. Harassment, active or passive

      Davis and Thomson 1984
      Fay 1981

Fay et al. 1984
Taggert and Zabel 1982
Taggert and Zabel 1983

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to Pacific walrus were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Morbidity/mortality by ingestion of petroleum
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Harassment, active or passive:

    a. Blasting

        Goertner 1982
        Hill 1978
        Hill 1978

    b. Human disturbance

        Fay et al. 1984

    c. Transport of personnel/equipment/material - air

        Davis and Thomson 1984
        Fay 1981
        Salter 1979
        Taggert and Zabel 1982

Taggert and Zabel 1983
Trasky 1984

d. Transport of personnel/equipment/material - land, ice

Fay 1981

e. Transport of personnel/equipment/material - water

Davis and Thomson 1984
Fay 1981
Fay et al. 1984
Taggert and Zabel 1982
Taggert and Zabel 1983

2. Shock waves (increase in hydrostatic pressure):

a. Blasting

Goertner 1982
Hill 1978
Hill 1978

ANNOTATED REFERENCES TO IMPACTS TO PACIFIC WALRUS

The annotated bibliography contains only references that discuss documented impacts to pacific walrus. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to pacific walrus are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Davis, R.A., and D.H. Thomson. 1984. Marine mammals. Pages 47-80 *in* J.C. Truett, ed. The Barrrow Arch environment and possible consequences of planned offshore oil and gas development. Proceedings of a synthesis meeting, Girdwood, AK, 1983. Environmental assessment of the Alaskan continental shelf. USDC:NOAA; USDI:BLM. 229 pp. (UAF)*

In this synthesis of research conducted in the Beaufort Arch region of the eastern Chukchi Sea, the reactions of Pacific walrus to human disturbance were briefly discussed. It was noted that herds of females and calves tended to stampede off ice pans when a ship approached, creating the potential for injury or death to calves from trampling by the larger animals, and to starvation or predation of calves separated from their mothers.

The documented impacts of harassment caused by transport of personnel/equipment/material - air (aircraft) and water (ships) were noted. The severity of response and distance from the source at which the response (in this case, stampeding off ice pans) occurred varied with the direction of approach of the stimulus, and with the type of stimulus. Ships approaching walrus from upwind caused stampeding at an average distance of 71 m (230 ft); whereas, from downwind the average distance was 207 m (630 ft). Aircraft flying below 300 m (1,000 ft) altitude caused stampedes. There was a subjective feeling that walruses react more to helicopters than to fixed-wing aircraft.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Fay, F.H. 1981. Conditions at Cape Seniavan, 8-12 April 1981. Unpubl. memo to ADFG, Fairbanks. 2 pp. (ADFG-F)

The author reports several observations of aircraft and pedestrian harassment of Pacific walrus hauled out on the beach at Cape Seniavan on the Alaska Peninsula in April 1981. He notes several instances in which small single-engine fixed-wing aircraft circled low [Rev. note: altitude was unspecified] over several hundred hauled-out walrus causing the walrus to stampede into the water and apparently leave the haulout. On one occasion a helicopter "buzzed" and landed near the walrus, and several people walked around the herd causing the walrus to stampede into the water. On another occasion a large twin-engined fixed-wing aircraft flew low over the animals and some of the herd stampeded into the water. Over a 5 d period the number of animals using the haulout declined dramatically; however, the author does not conclude that this decline was due to the frequent incidence of harassment.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Fay, F.H., B.P. Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. Final report of principal investigators, RU#611 (unpubl.). Environmental assessment of the Alaskan continental shelf. USDC:NOAA. USDI:BLM. 142 pp. (UAF)*

In this extensive report about the biology of Pacific walrus in the north Pacific and Arctic oceans the life history, population dynamics, habitat use, exploitation, and the effects of human disturbance of walrus are presented. Results of the authors' field research as well as a synthesis of other American and Soviet research and historical accounts are provided.

Documented impacts of harassment of walrus by ships and aircraft are discussed. Walrus are more responsive to such harassment while they are on terrestrial or ice haulouts than while they are in the water. The overt reactions of walrus to aircraft and ships ranges from a mild interruption of resting to panicked stampeding into the water. The most severe consequences of such stampedes could be the injury or death of calves trampled by the adults, and the separation from and subsequent abandonment of calves by their mothers. The authors report observations of coastal residents that there has been an increase in the number of abandoned walrus calves in the Bering and Chukchi seas coincident with the increase in shipping traffic to the North Slope. Although tracing the fate of calves separated from their mothers has been impossible under the environmental conditions under which this study was conducted, the authors point out that young walrus calves are totally dependent on their mothers and would surely starve or become victims of predation if they become separatead from their mother. One observation is reported of a polar bear killing a walrus calf that had been abandoned by its mother when she abandoned an ice floe upon the passage of a ship nearby.

The most common effect of harassment has been the abandonment of terrestrial or ice floe haulouts. Abandonment of haulouts has been most commonly described as temporary--i.e., a matter of several hours or days--although there have been documented cases of permanent abandonment of terrestrial haulouts as well. The authors note that in the 1930's walruses abandoned a large terrestrial haulout on the Soviet coast because of the frequent harassment by increased shipping traffic in the Anadyr River estuary. The authors also mention additional examples of terrestrial haulouts that were used historically by walruses but that are now considered "extinct" because increased human disturbance (e.g., construction activity) or shipping has precluded walruses from using them.

Contemporary observations of walrus responses to disturbance indicate that the severity of the animals' responses depends on several factors including weather conditions, ice conditions (i.e., whether there is a large amount of open water as opposed to broken ice), composition of the group (especially the presence of cows and calves), and characteristics of the disturbing stimulus such as its size, approach speed, and whether it approaches from the upwind or downwind direction. Walruses appear to be more reactive to disturbance when the weather is stormy than when it is clear. Females and calves are more reactive to disturbance than are bulls or immature animals. Walruses appear to react primarily to the odor and less so to the sight and noise of a harassing stimulus. Female and calf walrus abandoned an ice floe in response to the noise of an approaching ice breaker when the ship was 0.5-1.0 km (0.3-0.6 mi) distant; this was apparently due to the sound of breaking ice rather than just to the noise of the ship itself. In several instances the walruses did not overtly respond to the sight of a ship passing at a distance of several kilometers but abandoned their floe when the odor from the ship's exhaust reached them. In general approaches by ships from the downwind direction disturbed walrus at a distance of approximately one-third that of approaches from the upwind direction. Low-frequency engine noises (e.g., diesel engines) caused less disturbance than high-frequency engine sounds (e.g., outboard motors).

Activity: human disturbance; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Salter, R.E. 1979. Site utilization, activity budgets, and disturbance responses of Atlantic walruses during terrestrial haul-out. Can J. Zool. 57(6):1169-1180. (UAF)*

The overt reactions to human disturbance of Atlantic walruses (Odobenus rosmarus rosmarus) were studied on Bathurst Island, Northwest Territories, Canada, during July and August, 1977. The walruses hauled out on western Crozier Strait at a small gravel point with a 5 m (15 ft) intertidal zone. The walruses were subjected to at least one source of mechanical disturbance each 3 h because of intensive aircraft activity associated with nearby oil and gas survey operations. Helicopter (usually Bell 206B) and fixed-wing (DHC-6 Twin Otter and DHC-3 Single Otter) aircraft and small inflatable boats were common in the area. Pertinent observations and conclusions include the following:

(1) Mild reactions (e.g., raising the head and orienting toward the stimulus) to helicopters occurred when the aircraft were up to 8 km (5 mi) distance. Severe reactions (e.g. stampeding into the water) occurred when the helicopter flew less than 1.3 km (3/4 mi) from the haulout. On one occasion, the walruses abandoned the haulout for at least 9 h following the disturbance. These overflights were all at relatively low altitudes.

(2) Overflights by the DHC-3 at 300 m (1000 ft) altitude resulted in most of a large group of hauled-out walrus leaving the haulout.

(3) Inflatable boats did not come within 1.8 km (1 mi) of the haulout, and at that distance there was no detectable response by the walrus.

(4) The walruses did not respond at all to "natural" sounds such as falling or breaking ice.

The author mentioned that increased time in the water as a result of leaving the haulout could affect the thermoregulation of calves, which need to spend considerable time hauled-out of the icy water in order to remain warm. In this study the author did not see any evidence of calf mortality as a result of disturbance, nor did he find evidence that walrus changed their energy budgets in any detectable way.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Taggert, J. and C. Zabel. 1982. Six summers on Round Island. Alaska Fish Tails and Game Trails 14(3): 33-37. (UAF)#

This article for the general public summarizes some of the impacts of boat and aircraft traffic on the summer walrus haulout at Round Island. Boats and airplanes circling the island were observed to cause walrus to stampede off the beach and into the water. Youn walruses were trampled, and possibly killed, during these stampedes. Additionally, walrus which had hauled out at high tide were observed to fall to the rocks below when startled after the tide had dropped--this often resulted in broken tusks and injured flippers.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Taggert, J., and C. Zabel. 1983. 1983 Round Island field season report. Unpubl. MS, ADF&G, Anchorage. 4 pp. (HD)#

This report discussed visitor use of Round Island during summer 1983. Because of the dramatic increase in sightseers, and the accompanying increase in boat and aircraft traffic to Round Island, not only is the value of the experience decreased for the visitor but the harassment of walrus increased. Airplane landings were observed to be especially disruptive, often causing the walrus to stampede into the water. There was a significant decline in the number of walrus hauling out at Round Island in 1983--this may have been a result of the increased human disturbance; however, other factors could also have been responsible.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Trasky, L.L. 1984. Region IV monthly report, May 1984. Unpubl. memo, ADF&G, Division of Habitat. 7 pp. (HD)

The author reported an observation of harassment of Pacific walrus on Round Island in the Bering Sea. A fish processor went aground northwest of the island in April 1984, and spilled diesel fuel. Overflights of a C-130 Hercules aircraft monitoring the spill caused all of the estimated 3,000 to 5,000 walrus hauled-out on Round Island to abandon the haulout for up to 3 d.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

5. Polar Bear

Table 1. Impacts Associated With Each Activity - Polar Bear

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source														X								X								
Barriers to movement, physical and behavioral																														
Collision with vehicles or structures																														
Entanglement in fishing nets, debris																														
Entrapment in impoundments or excavations																														
Harassment, active or passive	?						?	?						X					?								?	X	?	
Harvest, change in level	?													X																
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				?															?						X	X				
Parasitism/predation, increased susceptibility																														
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction																														
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

5. POLAR BEAR - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on polar bears. Each citation refers to an annotation in the following section, Annotated References to Impacts on Polar Bears. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to polar bear are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to polar bear were found for the following activities:

Blasting
Burning
Channelizing waterways
Chemical application
Clearing and tree harvest
Draining
Dredging
Drilling
Fencing
Filling and pile-supported structures (aquatic)
Filling (terrestrial)
Grading/plowing
Grazing
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Processing oil/gas
Sewage disposal
Stream crossing - fords
Stream crossing - structures
Transport of personnel/equipment/material - air
Transport of personnel/equipment/material - water
Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Human disturbance:

   a. Attraction to artificial food source

      Bromley 1985
      Lunn and Stirling 1985
      Stirling et al. 1977
      Wooldridge 1980

   b. Harassment, active or passive

      Bromley 1985
      Lunn and Stirling 1985
      Stirling et al. 1977
      Wooldridge 1980

   c. Harvest, change in level

      Bromley 1985
      Lunn and Stirling 1985
      Stirling et al. 1977
      Wooldridge 1980

2. Solid waste disposal:

   a. Attraction to artificial food source

      Bromley 1985
      Lunn and Stirling 1985
      Stirling et al. 1977

3. Transport of oil/gas/water - land, ice:

   a. Morbidity/mortality by ingestion of petroleum

      Engelhardt 1983
      Hurst and Oritsland 1982
      Oritsland et al. 1981

4. Transport of oil/gas/water - water:

   a. Morbidity/mortality by ingestion of petroleum

      Engelhardt 1983

Hurst and Oritsland 1982
Oritsland et al. 1981

5. Transport of personnel/equipment/material - land, ice:

   a. Harassment, active or passive

      Amstrup 1985

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to polar bear were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

    a. Human disturbance

        Bromley 1985
        Lunn and Stirling 1985
        Stirling et al. 1977
        Wooldridge 1980

    b. Solid waste disposal

        Bromley 1985
        Lunn and Stirling 1985
        Stirling et al. 1977

2. Harassment, active or passive:

    a. Human disturbance

Bromley 1985
Lunn and Stirling 1985
Stirling et al. 1977
Wooldridge 1980

b. Transport of personnel/equipment/material - land, ice

Amstrup 1985

3. Harvest, change in level:

a. Human disturbance

Bromley 1985
Lunn and Stirling 1985
Stirling et al. 1977
Wooldridge 1980

4. Morbidity/mortality by ingestion of petroleum:

a. Transport of oil/gas/water - land, ice

Engelhardt 1983
Hurst and Oritsland 1982
Oritsland et al. 1981

b. Transport of oil/gas/water - water

Engelhardt 1983
Hurst and Oritsland 1982
Oritsland et al. 1981

ANNOTATED REFERENCES TO IMPACTS TO POLAR BEARS

The annotated bibliography contains only references that discuss documented impacts to polar bears. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to polar bears are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Amstrup, S. 1985. Memo to Glen Elison, Refuge Manager, Arctic NWR, USFWS. 2 pp. (ADF&G-F, Habitat)*

A radio-tagged bear that "gave every indication of being pregnant" denned near the mouth of the Canning River in the winter or 1984-1985 where she would have normally stayed until late March. She was located there on December 2 and 27, 1984, but had abandoned the den by the week of February 11, 1985, when she was seen alone on the sea ice near Barrow. An aerial survey of the den area of February 28, 1985, showed a single set of caterpillar tractor tracks within 200-250 m of the den site, a well-traveled cat train route within 450-500 m, and a lesser-used route about 800 m from the den. Vehicular activity probably took place in late January, which would have been about the time of parturition. Amstrup concluded that although other factors for her early abandonment of her den and presumed loss of her cubs cannot be ruled out, "I must suspect disturbances associated with the movement of equipment near the den site were involved."

Activity: transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Bromley, M. 1985. Safety in bear country: a reference manual. Northwest Territories Dept. Renewable Resources, Yellowknife. (ADF&G-F, Habitat)*

This report provides an excellent summary of measures to avoid or reduce bear-human encounters that often result in human injury, destruction of property, and death of bears. This report was written to address bear-human problems encountered in the Northwest Territories, Canada; however, much of the information presented is applicable to Alaskan situations. Information on bear biology and behavior is presented for black, brown, and polar bears, including examples of bear-human encounters. Topics discussed in detail include bear detection systems for camps, camp design and maintenance, and deterance methods for personnel and facilities. The activities of human disturbance and solid waste disposal produced documented impacts to bears of attraction to an artificial food source and an increase in harvest. Bears were attracted to improperly handled food and garbage, and many were then shot in "defense of life and property."

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4:199-217. (ADF&G-A, Habitat)*

This review article summarizes data from both case reports and investigations of actual oil spills, as well as recent experimental evidence. Although mortality as been attributed to oil exposure at sea in case reports, the evidence has generally not been conclusive in defining the toxicity of petroleum to seals, sea otters, or whales.

After exposure to oil, ringed seal pelage that had been completely coated cleaned itself after 1 d in sea water. Captive sea otters and polar bears greatly increased the grooming of their oil-fouled fur, ingesting oil that resulted in injury or death. Shortly after exposure, sea otters and ringed seals began quivering, probably as a result of neurotoxic volatile hydrocarbons. Oil residues were found primarily in the blubber and liver of ringed seals beginning 2 d after exposure to oil. In the three polar bears tested, kidneys, the brain, and bone marrow carried the highest petroleum residue load; no residues were detected in the adipose tissue. Both polar bears and ringed seals have the capacity to clear hydrocarbons by urine and bile. Oiled polar bear pelt samples showed increased thermal conductance; oiled sea otters nearly doubled their metabolic rate; oiled ringed seals showed no decrease in core temperature, presumably because they rely on a blubber layer rather than their pelage for insulation.

In general, response of sea otters to petroleum exposure was primarily severe thermal and metabolic stress, often leading to death. Ringed seals showed "limited toxic response," including reversible eye irritation and absorbtion and distribution of residues throughout tissues, but there were no major pathological effects. Two of three polar bears exposed to crude oil on sea water died. The third bear recovered fully but only after several months of treatment and care.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Hurst, R.J., and N.A. Øritsland. 1982. Polar bear thermoregulation: effect of oil on the insulative properties of fur. J. Therm. Biol. 7:201-208. (ADF&G-A, Habitat)*

Laboratory tests were conducted on seven fur samples from the mid-back region of three subadult polar bears taken in October in northern Canada. Tests were conducted under winter and summer conditions, with and without solar radiation, at different wind speeds and with three different kinds of oil. After contamination with oil, the calm air heat transfer coefficient increased by a factor of 2 to 5; the wind coefficient averaged 290% greater, and the solar utilization increased by 55%. Conductance remained high over time at the winter test temperatures (T = -0.6° C.) but decreased at summer temperatures (T = 24.7° C.) due to "melting." The most viscous of the three oils tested had the most negative effect. The authors conclude that "compensatory increases in the metabolic rate of polar bears would have to be large at low ambient temperatures to counteract the suggested decrease in fur insulation caused by oil exposure. A change in insulation of the magnitude found in this study thus represents a serious strain on the heat balance and the thermoregulatory stability of an oil-contaminated polar bear."

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Lunn, N.J., and I. Stirling. 1985. The significance of supplemental food to polar bears during the ice-free period of Hudson Bay. Can. J. Zool. 63:2291-2297. (ADF&G-A, Habitat)

The Churchill, Manitoba, dump, a large and reliable food source, has existed since the early 1960's. Some bears have not only learned its location but show a high degree of seasonal fidelity and some cubs, once weaned, return to the dump on their own. Polar bears have been studied near Churchill by the Canadian Wildlife Service since 1966. In addition to data from previous studies, bears were studied in summer 1982 and 1983 and the autumns of 1981-1983. Females and males, adults, subadults, and cubs were all observed. Bears feeding at the dump were significantly heavier but did not show increased survival or increased litter size over bears that did not feed at the dump. The authors conclude that although polar bears will investigate and use supplemental food sources if they are available, the Churchill dump is not critical to their survival.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Øritsland, N.A., F.R. Englehardt, F.A. Juck, R.J. Hurst, and P.D. Watts. 1981. Effect of crude oil on polar bears. Environmental Studies No. 24, Dept. Indian and Northern Affairs, Ottawa, Ontario, Can. 268 pp. (ARL)*

Three subadult polar bears were captured near Churchill, Manitoba, and transported to the Churchill Polar Bear Laboratory, where they were caged separately, exposed to medium viscosity Midale crude oil (as a slick on sea water at ambient temperatures), and subsequently observed. Two of the three bears died from kidney damage; the third required extensive treatments but survived. After exposure, the bears groomed their fur and ingested oil. "Considerable" increases in both metabolism and skin temperature were recorded; for resting polar bears, the metabolic rate nearly doubled. Uptake of petroleum hydrocarbons and their distribution to body tissues led to behavioral abnormalities, acute anemia, and tissue damage, especially to the kidneys. This study investigated only the effects of acute exposure of polar bears to oil; the authors recommend study of chronic exposure as well.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Stirling, I., C. Jonkel, P. Smith, R. Robertson, and D. Cross. 1977. The ecology of the polar bear (Ursus maritimus) along the western coast of Hudson Bay. Occas. Pap. No. 33, Can. Fish. Wildl. Serv., Ottawa, Ont. 64 pp. (ADF&G-F, Game)*

Data from 1966-1976 are summarized in this report, which includes management history, tagging and radio-tracking results, aerial and denning surveys, ages and measurements, and a population estimate, as well as the history of human-bear interactions in the region. Apparently because of the decrease in hunting pressure, numbers of polar bears increased greatly along the Manitoba coast in the 1960's and therefore increased also at the three dumps in Churchill and Fort Churchill. The human population of the area was then at its highest, and the number of human-bear conflicts increased. Bears attracted to an artificial food source (the dump) were often bold and aggressive and were more likely to become "problem bears" and then killed or captured for zoos. Efforts were made to burn and bury the garbage, move or close the dumps, fence the area, change the hunting regulations in the area, build an incinerator, and relocate problem bears 300 km south of Churchill rather than killing them. None of the remedies had been completely successful by the date of the report.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Wooldridge, D.R. 1980. Polar bear electronic deterrent and detection systems. Pages 264-269 in E.C. Meslow, ed. Bears - their biology and management. Fifth International Conference on Bear Research and Management, Madison, WI, Feb. 1980. (ADF&G-F, Game)*

Responses of free-ranging polar bears to acoustic and electrified-fence repellents and to trip wire and proximity detection systems were evaluated in a 4 yr study conducted in Churchill, Manitoba. The study was initiated when an employee at an ESSO offshore drilling rig was killed and eaten by a subadult male polar bear in the Beaufort Sea. Results show that acoustic repellents and electrified fences can repel polar bears and that trip-wire detection systems can be relied on to provide a high degree of protection, thus reducing the number of potentially dangerous human-bear encounters. See the article for details of repellents and fence construction.

Activity: human disturbance.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

6. Ringed Seal

Table 1. Impacts Associated With Each Activity - Ringed seal

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source																														
Barriers to movement, physical and behavioral										?																				
Collision with vehicles or structures																														
Entanglement in fishing nets, debris																?														
Entrapment in impoundments or excavations																														
Harassment, active or passive	X						?			?				X			?		?	?							X	X		
Harvest, change in level																														
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum	?			X															?	?	?	?			X	X				
Parasitism/predation, increased susceptibility																														
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction																														
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

6. RINGED SEAL - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on ringed seal. Each citation refers to an annotation in the following section, Annotated References to Impacts on Ringed Seal. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to ringed seal are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to ringed seal were found for the following activities:

- Burning
- Channelizing waterways
- Clearing and tree harvest
- Draining
- Dredging
- Drilling
- Fencing
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Grading/plowing
- Grazing
- Log storage/transport
- Netting
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing minerals (including gravel)
- Processing oil/gas
- Sewage disposal
- Solid waste disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of personnel/equipment/material - water
- Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

    a. Harassment, active or passive

        Burns and Kelly 1982
        Goertner 1982
        Hill 1978
        Kelly et al. 1986

    b. Shock waves (increase in hydrostatic pressure)

        Goertner 1982
        Hill 1978

2. Chemical application:

    a. Morbidity/mortality by ingestion of petroleum

        Helle 1981
        Helle et al. 1976a
        Helle et al. 1976b

3. Human disturbance:

    a. Harassment, active or passive

        Burns and Kelly 1982
        Kelly et al. 1986

4. Transport of oil/gas/water - land, ice:

    a. Morbidity/mortality by ingestion of petroleum

        Engelhardt 1982
        Engelhardt 1983
        Engelhardt et al. 1977
        Geraci and Smith 1976

5. Transport of oil/gas/water - water:

    a. Morbidity/mortality by ingestion of petroleum

        Engelhardt 1982
        Engelhardt 1983
        Engelhardt et al. 1977
        Geraci and Smith 1976

6. Transport of personnel/equipment/material - air:

   a. Harassment, active or passive

      Kelly et al. 1986

7. Transport of personnel/equipment/material - land, ice:

   a. Harassment, active or passive

      Burns and Kelly 1982
      Kelly et al. 1986

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to ringed seal were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

1. Harassment, active or passive:

   a. Blasting

      Burns and Kelly 1982
      Goertner 1982
      Hill 1978
      Kelly et al. 1986

   b. Human disturbance

      Burns and Kelly 1982
      Kelly et al. 1986

   c. Transport of personnel/equipment/material - air

      Kelly et al. 1986

   d. Transport of personnel/equipment/material - land, ice

      Burns and Kelly 1982
      Kelly et al. 1986

2. Morbidity/mortality by ingestion of petroleum:

   a. Chemical application

      Helle 1981
      Helle et al. 1976a
      Helle et al. 1976b

   b. Transport of oil/gas/water - land, ice

      Engelhardt 1982
      Engelhardt 1983
      Engelhardt et al. 1977
      Geraci and Smith 1976

   c. Transport of oil/gas/water - water

      Engelhardt 1982
      Engelhardt 1983
      Engelhardt et al. 1977
      Geraci and Smith 1976

3. Shock waves (increase in hydrostatic pressure):

   a. Blasting

      Goertner 1982
      Hill 1978

ANNOTATED REFERENCES TO IMPACTS TO RINGED SEALS

The annotated bibliography contains only references that discuss <u>documented</u> impacts to ringed seals. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to ringed seals are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Burns, J.J., and B.P. Kelly. 1982. Studies of ringed seals in the Alaskan Beaufort Sea during winter: impacts of seismic exploration. Ann. Rept., RU-232. 57 pp. (ADF&G-F, Game)*

In 1982, the direct impact of seismic exploration on ringed seals in the nearshore Beaufort Sea was documented by determining the fates of subnivian structures and the density of seals (as determined by aerial survey) in relation to seismic activities. The 148 subnivian breathing holes, haul-out, and birth lairs found along seismic and control lines were analyzed for differences in fate with distance from the search line. Along control lines there was no difference in fates as a function of distance. Along seismic lines, 54% of the structures within 150 m of the lines remained open and unaltered; beyond that distance (an arbitrary distance chosen by the investigators), 78% remained open and unaltered. The magnitude of natural freezing or alteration in undisturbed structures is unknown.

Aerial surveys showed no significant difference in the density of seals along seismic lines and control lines.

The authors conclude that some localized displacement of ringed seals occurs in the immediate area of seismic lines but that the overall effect on the ringed seal population in the nearshore Beaufort Sea is insignificant.

Activity: blasting; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Engelhardt, F.R. 1982. Hydrocarbon metabolism and cortisol balance in oil-exposed ringed seals, Phoca hispida. Comp. Biochem. Physiol. 72C:133-136. (ADF&G-A, Habitat)*

Four subadult ringed seals were captured near Cape Parry, NWT, fed fish containing 5 ml of radio-labelled Norman Wells crude oil for 4 d, and samples of their blood were taken for cortisol and hydrocarbon determinations after dosing. Mixed function oxidase activity was determined in liver and kidney tissues of four wild ringed seals (shot near the capture site of the experimental animals and assumed to be uncontaminated with petroleum hydrocarbons) and in the four oil-exposed seals. Mixed function oxidase activity was induced in kidney tissues and was correlated with a high degree of conversion of crude oil hydrocarbons to watersoluable metabolites; most of the radioactivity was found in the urine and plasma. Plasma cortisol levels, a nonspecific response to stress, were somewhat elevated as a result of captivity and increased markedly after oil-exposure. "A disturbance in cortisol cycle and balance, or its response capacity, may be expected to be deleterious to seals." The author also raises, but does not answer, the question of an eventual adreno-cortical exhaustion resulting from chronic polyaromatic hydrocarbon exposure.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4:199-217. (ADF&G-A, Habitat)*

This review article summarizes data from both case reports and investigations of actual oil spills as well as recent experimental evidence. Although mortality has been attributed to oil exposure at sea in case reports, the evidence has generally not been conclusive in defining the toxicity of petroleum to seals, sea otters or whales.

After exposure to oil, ringed seal pelage that had been completely coated cleaned itself after one day in sea water. Captive sea otters and polar bears greatly increased the grooming of their oil-fouled fur, ingesting oil that resulted in injury or death. Shortly after exposure, sea otters and ringed seals began quivering, probably as a result of neurotoxic volatile hydrocarbons. Oil residues were found primarily in the blubber and liver of ringed seals beginning two days after exposure to oil. In the three polar bears tested, kidney, brain and bone marrow carried the highest petroleum residue load; no residues were detected in the adipose tissue. Both polar bears and ringed seals have the capacity to clear hydrocarbons by urine and bile. Oiled polar bear pelt samples showed increased thermal conductance; oiled sea otters nearly doubled their metabolic rate; oiled ringed seals showed no decrease in core temperature, presumably because they rely on a blubber layer rather than their pelage for insulation.

In general, response of sea otters to petroleum exposure was primarily severe thermal and metabolic stress, often leading to death. Ringed seals showed "limited toxic response" including reversible eye irritation, and absorption and distribution of residues throughout tissues, but there were no major pathological effects. Two of three polar bears exposed to crude oil on sea water died. The third bear recovered fully but only after several months of treatment and care.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Engelhardt, F.R., J.G. Geraci, and T.G. Smith. 1977. Uptake and clearance of petroleum hydrocarbons in the ringed seal, _Phoca hispida_. J. Fish. Res. Bd. Can. 34:1143-1147. (ADF&G-A, Habitat)*

Six ringed seals were immersed in sea water holding pens at Brown's Harbor, NWT covered by a 1 cm (0.4 in) thick slick of Norman Wells crude oil for 24 h. Five other seals were fed fish containing oil at a dose of 5 ml oil per seal per day for 5 days. Ages of seals were not given. Tissues and body fluids for controls for both studies were taken from six seals shot near the capture site of the experimental seals (Cape Parry, NWT) and assumed to be uncontaminated with petroleum hydrocarbons. Ringed seals showed rapid absorption of hydrocarbons into body tissues and fluids when exposed both by immersion and ingestion. Relatively low but significant levels were found in tissue, blood, and plasma, but levels in the bile and urine were high and some renal tubular necrosis was seen, indicating these to be the routes of excretion.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Geraci, J.R., and T.G. Smith. 1976. Direct and indirect effects of oil on ringed seals (Phoca hispida) of the Beaufort Sea. J. Fish. Res. Bd. Can. 33:1976-1984. (UAF)*

In autumn 1974, six ringed seals captured near Brown's Harbor, NWT, were immersed in a seawater pool covered with a slick of Norman Wells crude oil for 24 hrs. Transient eye irritations, minor kidney and possible liver lesions were noted, but no permanent damage was observed. Three seals transported to the University of Guelph and immersed in oil-covered water all died within 71 min of immersion. Hematological studies indicate that death was due to the stress of captivity superimposed on the effects of the oil.

In March 1974, six white-coated (3-4 wk old) harp seal (Phoca groenlandica) pups were coated with crude oil on the Magdalen Islands. Harp seal pups were used because ringed seal pups were not available. Three other pups were used as controls, and all were later killed for internal examination. No significant changes in body temperature or deleterious effects were noted.

Five captive ringed seals were subjected to a cumulative dosage of 50 ml crude oil fed with their fish food. High dosage (75 ml) and low dosage (25 ml) of crude oil were fed to two groups of six harp seal pups. No significant lesions or behavioral changes were noted.

All experiments were only of acute effects; the authors recommend that studies on chronic effects be conducted.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Helle, E. 1981. Reproductive trends and occurrence of organochlorines and heavy metals in the Baltic seal populations. Unpubl. rept, Marine Environmental Quality Committee, International Council for the Exploration of the Sea, C.M. 1981/E:37. 13 pp. (ADF&G-F, Game)*

Tissues of ringed seals in the Baltic Sea were analyzed for levels of total DDT, mercury, selenium, cadmium, zinc, and chromium in relation to age, sex, and reproductive status of the female in 1974-1979. The season of collection was not given. The productivity of the Baltic seal stocks decreased sharply during the 1970's. Less than 25% of the sexually mature females reproduced normally in the Gulf of Bothnia (Baltic Sea) due to an increasing number of occlusions of the uterine tract. The same pathological change has been reported for grey seals and harbor seals. Both PCBs and total DDT levels in ringed seal tissues from the Gulf of Bothnia peaked in 1977. No statistical differences in levels were found between sexes or the reproductive categories of females in 1977-1978, although they were statistically different in 1974-1975. Mercury and selenium levels in the liver were higher in females than in males; no differences were noted between the sexes for cadmium, zinc, and chromium. The relationship between high levels of environmental toxins and reproductive failures in seal populations is "highly complex and organochlorines and heavy metals may have combined effects."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Helle, E.M., M. Olsson, and S. Jensen. 1976a. DDT and PCB levels and reproduction in ringed seal from the Bothnian Bay. Ambio 5:188-189. (ADF&G-F, Game)*

In October and November of 1973 and 1974, 40 sexually mature female ringed seals were collected from Bothnian Bay in the Baltic Sea. Only 27% were pregnant compared to a normal 80-90% in areas with low levels of pollution. Significantly higher levels of both DDT and PCB were found in the nonpregnant females compared with the pregnant females. In November, about 4 mo before the normal pupping season, about half of the nonpregnant females showed enlarged uteri and scars on the uterine wall indicating that implantation had occurred, followed by resorption or abortion. Similar reproductive disturbances have been reported for California sea lions with high levels of PCBs; the authors conclude that "it seems probable that PCB and not DDT substances are responsible for the perturbation of reproduction in seals."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Helle, E., M. Olsson, and S. Jensen. 1976b. PCB levels correlated with pathological changes in seal uteri. Ambio 5:261-263. (ADF&G-F, Game)*

In October and November 1975, 24 sexually mature males and 109 sexually mature females were collected from Bothnian Bay in the Baltic Sea. About 40% of the females showed pathological changes of the uterus. The uterine horns were closed by stenosis and occlusions, which prevented any passage from the ovary out through the horn and explained the low reproductive rate. Animals showing these changes had significantly higher levels of DDT and PCB than normal pregnant females. A significant positive correlation between DDT and PCB levels and age was found in the males but not in the females. The levels of DDT and PCB substances were somewhat lower in fetuses than in their mothers. The authors conclude, "It is strongly indicated that PCB is responsible for the reproductive failure of seals in the Baltic area."

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Kelly, B.P., L. Quakenbush, and J.R. Rose. 1986. Ringed seal winter ecology and impacts of noise disturbance. RU232, part 2. In Environmental assessment of the Alaskan continental shelf. Final reports (draft) of principal investigators. USDC, NOAA, USDI, BLM. (UAF)

The use by ringed seals of subnivean breathing holes and lairs during undisturbed periods and during periods when seals were subjected to various types of human disturbance was studied in the Beaufort Sea and Kotzebue Sound. The study was conducted during the period of March to May in 1982 through 1984. Seal structures (lairs or breathing holes) were initially located using a trained Labrador retriever as a search dog. Once seals were located several were tagged with radio transmitters and repeated radio locations were taken during the experimental phase. A simulated seismic survey was conducted in the Beaufort Sea study area during the 1983 field season. The simulation consisted of a seismic train with a "vibroseis" unit which followed a predetermined course and conducted routine seismic operations.

Although this report provided considerable information about the use of subnivean structures by ringed seals, the following discussion is limited to information concerning the impacts of harassment of seals by sources of human disturbance. In general, the reactions of seals to human disturbance were quite variable; therefore, "critical distances" were difficult to determine. Some of the variability in response could be related to conditions at the lair (e.g., background wind and ice noise, location of the lair--leeward or windward of an ice ridge). In other cases the frequency of the disturbance could have affected the variability. Seals temporarily abandoned lairs when helicopters flew over at altitudes at or below 450 m (1,400 ft), when snowmachines passed within 0.5 to 2.8 km (.3 to 1.7 mi), or when people on foot passed within 200 m (700 ft). Only one seal was observed to abandon its lair following the vibroseis test; that animal abandoned its lair for several d after the seismic train came within 644 m (2,000 ft) of its lair and premanently abandoned its lair 5 d later.

Harassment of seals, especially molting adults and young pups, in their lairs can have serious consequences because of the thermal loss when animals are forced to abandon the lair and spend more time in the cold water. Newborn pups in lanugo, before they have developed a blubber layer, are especially susceptible to heat loss due to immersion in icy water. Adults during molt, when they are maximizing lair use during the period of new hair growth, are also susceptible to hypothermia when they are forced to abandon the lair.

Activity: blasting; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

7. Sea Otter

Table 1. Impacts Associated With Each Activity - Sea otter

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change			?	?		?	?			?				?	?			?	?	?	?	?				?	?		?	
Attraction to artificial food source	?						?	?													?	?								
Barriers to movement, physical and behavioral	?						?	?		?					?		?	?	?	?	?					?		?	?	
Collision with vehicles or structures							?	?		?					?		?	?	?	?						?		?	?	
Entanglement in fishing nets, debris							?	?		?					?	X	?	?	?	?		?				?			?	
Entrapment in impoundments or excavations	?		?			?	?								?															
Harassment, active or passive	X		?			?	?	?		?				?	?		?	?	?	?						?	?		X	
Harvest, change in level			?											?	?		?	?	?	?						?			?	
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				?				X										?	?	X						X			?	
Parasitism/predation, increased susceptibility	?		?	?			?			?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Prey base, alteration of	?		?	?			?			?				?	?			?	?	?	?					?			?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?						?								?															
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

7. SEA OTTER - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on sea otter. Each citation refers to an annotation in the following section, Annotated References to Impacts on Sea Otter. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to sea otter are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to sea otter were foutd for the following activities:

- Burning
- Channelizing waterways
- Chemical application
- Clearing and tree harvest
- Draining
- Dredging
- Fencing
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Grading/plowing
- Grazing
- Human disturbance
- Log storage/transport
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing minerals (including gravel)
- Sewage disposal
- Solid waste disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - land, ice
- Transport of personnel/equipment/material - air
- Transport of personnel/equipment/material - land, ice
- Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Goertner 1982
      Hill 1978

   b. Shock waves (increase in hydrostatic pressure)

      Goertner 1982
      Hill 1978
      Rausch 1973

2. Drilling:

   a. Morbidity/mortality by ingestion of petroleum

      Calkins 1983
      Costa and Kooyman 1982
      Engelhardt 1983
      Kooyman et al. 1977
      Siniff et al. 1982

3. Netting:

   a. Entanglement in fishing nets, debris

      Marine Mammal Commission 1986
      Matkin and Fay 1980

4. Processing oil/gas:

   a. Morbidity/mortality by ingestion of petroleum

      Calkins 1983
      Costa and Kooyman 1982
      Engelhardt 1983
      Kooyman et al. 1977
      Siniff et al. 1982

5. Transport of oil/gas/water - water:

   a. Morbidity/mortality by ingestion of petroleum

      Calkins 1983
      Costa and Kooyman 1982

Engelhardt 1983
Kooyman et al. 1977
Siniff et al. 1982

6. Transport of personnel/equipment/material - water:

   a. Harassment, active or passive

      Garshelis and Garshelis 1984

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to sea otter were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Entanglement in fishing nets, debris:

   a. Netting

      Marine Mammal Commission 1986
      Matkin and Fay 1980

2. Harassment, active or passive:

   a. Blasting

      Goertner 1982
      Hill 1978

   b. Transport of personnel/equipment/material - water

      Garshelis and Garshelis 1984

3. Morbidity/mortality by ingestion of petroleum:

   a. Drilling

      Calkins 1983
      Costa and Kooyman 1982
      Engelhardt 1983
      Kooyman et al. 1977
      Siniff et al. 1982

   b. Processing oil/gas

      Calkins 1983
      Costa and Kooyman 1982
      Engelhardt 1983
      Kooyman et al. 1977
      Siniff et al. 1982

   c. Transport of oil/gas/water - water

      Calkins 1983
      Costa and Kooyman 1982
      Engelhardt 1983
      Kooyman et al. 1977
      Siniff et al. 1982

4. Shock waves (increase in hydrostatic pressure):

   a. Blasting

      Goertner 1982
      Hill 1978
      Rausch 1973

ANNOTATED REFERENCES TO IMPACTS TO SEA OTTERS

The annotated bibliography contains only references that discuss documented impacts to sea otters. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to sea otters are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Calkins, D. 1983. Marine mammals of Lower Cook Inlet and the potential for impact from Outer Continental Shelf oil and gas exploration, development, and transport. Pages 171-263 in Environmental assessment of the Alaskan continental shelf. Final reports of principal investigators. Vol. 20: Biological studies. USDC:NOAA. USDI:BLM. Anchorage. (HD)#

This report summarizes potential and documented impacts of oil and gas-related activities on marine mammals of lower Cook Inlet and Shelikof Straits area. Although most of the impacts that are discussed are potential rather than documented, the following documented impacts are presented:

(1) Oil pollution has caused morbidity and mortality in sea otters because of fouling of the otter's fur, upon which it relies to maintain thermoregulation.

(2) Oil pollution has also caused temporary blindness in grey seals (related to harbor seals), and damage to the eyes and kidneys of ringed seals (also related to harbor seals).

(3) Low-level flights by aircraft over harbor seal and Steller sea lion rookeries and haulouts have resulted in harassment. Animals have stampeded off the rookeries or haulouts; however, the responses varied with the environmental conditions (e.g., weather, sea state) as well as characteristics of the approaching aircraft.

The author also reported that a twin engine airplane flying 300 m (1,000 ft) above a group of belukha whales caused the animals to retreat to deep water.

(4) Human ground traffic (e.g., hikers, all-terrain vehicles) caused the abandonment of haulouts of Steller sea lion in California, and haulouts of harbor seals and Steller sea lions in another undisclosed location.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Costa, D.P. and G.L. Kooyman. 1982. Oxygen consumption, thermoregulation, and the effects of fur oiling and washing on the sea otter, _Enhydra lutris_. Can. J. Zool. 60: 2761-2767. (UAF)*

In this laboratory study the investigators measured the metabolic and behavioral changes of captive sea otters when exposed to a small amount of Prudho Bay crude oil on their fur. The otters were held in tanks with natural sea water at ambient temperatures (for California) of 20°C during summer and 16°C during winter. Crude oil was introduced to the tanks and the otters were either left in the tanks or removed and washed with detergent, and then returned to the tanks. Although the amount of crude oil spread on the surface of the tanks was small, because the animals groomed often the crude oil eventually contaminated most of their fur. The investigators' findings include the following:

(1) Animals left unwashed for 8 d doubled their metabolic requirement within 6 d when returned to the water at the summer temperature.

(2) One otter after being returned to the 16°C water exhibited signs of lower body temperature and died of pneumonia within 11 d.

(3) Sea otters compensate for increased thermal conductance by: increasing their activity (and heat production) rather than by increasing their non-active metabolic rate; increasing their buoyancy in the water so that less of their body surface is exposed to cold water; increasing vasoconstriction to maintain a higher "core" body temperature; and using their paws for thermoregulation by holding them close to the body when ambient temperature is low and extending them in the air as "radiators" when the ambient temperature is high.

(4) Washing otters with detergent ("Amber Lux") increased the thermal conductance of their fur for 8 d, but after that the otter's natural oil production increased to normal levels and the fur regained its normal conductance.

As a consequence of finding # 4, the investigators recommend that if sea otters become fouled with oil they should be washed with detergent _only_ if they can be kept in 20°C water for at least 8 d to allow their fur to regain its natural oil.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4:199-217. (ADF&G-A, Habitat)*

This review article summarizes data from both case reports and investigations of actual oil spills as well as recent experimental evidence. Although mortality has been attributed to oil exposure at sea in case reports, the evidence has generally not been conclusive in defining the toxicity of petroleum to seals, sea otters or whales.

After exposure to oil, ringed seal pelage that had been completely coated cleaned itself after one day in sea water. Captive sea otters and polar bears greatly increased the grooming of their oil-fouled fur, ingesting oil that resulted in injury or death. Shortly after exposure, sea otters and ringed seals began quivering, probably as a result of neurotoxic volatile hydrocarbons. Oil residues were found primarily in the blubber and liver of ringed seals beginning two days after exposure to oil. In the three polar bears tested, kidney, brain and bone marrow carried the highest petroleum residue load; no residues were detected in the adipose tissue. Both polar bears and ringed seals have the capacity to clear hydrocarbons by urine and bile. Oiled polar bear pelt samples showed increased thermal conductance; oiled sea otters nearly doubled their metabolic rate; oiled ringed seals showed no decrease in core temperature, presumably because they rely on a blubber layer rather than their pelage for insulation.

In general, response of sea otters to petroleum exposure was primarily severe thermal and metabolic stress, often leading to death. Ringed seals showed "limited toxic response" including reversible eye irritation, and absorption and distribution of residues throughout tissues, but there were no major pathological effects. Two of three polar bears exposed to crude oil on sea water died. The third bear recovered fully but only after several months of treatment and care.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Garshelis, D., and J. Garshelis. 1984. Movements and management of sea otters in Alaska. J. Wildl. Manage. 48(3):665-678. (UAF)*

This report summarizes field research on sea otters in Prince William Sound. Aerial and surface surveys and radiotracking of sea otters were conducted between April 1979-September 1982. Sea otters used some areas preferentially for resting and some areas preferentially for feeding although all areas could be used for both. Nonbreeding males occupied "male areas" which were often separate from "female areas" which contained females and territorial (breeding) males. Seasonal movements among male areas were believed to be influenced by seasonal changes in boat traffic coincident with the commercial fisheries season. Suitable habitat between male areas was not used, and this observation was thought to be due to high levels of disturbance by boats present in these areas as opposed to the isolated bays which males used for resting and feeding. The only consistently used male haulout was a shallow area impassable to boats. Conversely, when some commercial crab fishing areas were closed, and boat traffic declined, sea otters moved into the same areas which had been avoided when levels of boat traffic were high.

Documented impact was passive harassment due to boat traffic. Utilization of passive harassment, and active harassment in the form of scaring devices, was also discussed as a management tool to decrease the effects of sea otter predation on commercial shellfish populations.

Activity: transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Kooyman, G., R. Davis, and M. Castellini. 1977. Thermal conductance of immersed pinniped and sea otter pelts before and after oiling with Prudhoe Bay crude. Pages 151-157 in Wolfe, D., ed. Fate and effects of petroleum hydrocarbon in marine organisms and ecosystems. Pergamor Press. 478 pp. (UAF)*#

The thermal conductance of pelts of California sea lion, northern fur seal, sea otter, Weddell seal, bearded seal, and walrus was measured during immersion in sea water, after oiling, and after washing. The "natural" thermal conductance of the sea lion and phocid seal pelts are high. The conductance of the walrus pelt was low, but the authors attributed this fact to the extreme thickness (5 cm) of the hide and suggested that conductance would be much higher in live walrus. The "natural" conductance of sea otter and fur seals was low; this fact suggests that the fur is extremely important for thermoregulation, especially in the sea otter. Likewise, the lanugo of phocid seal newborn pups (Wedell seal in this experiment) has a low conductance, and is an important means by which the pup can thermoregulate until it has nursed sufficiently long enough to develop a blubber layer.

The authors emphasized the importance of grooming to sea otter and fur seals in order to maintain the low thermal conductance of their coats. After oiling and washing the pelts in detergent, thermal conductance of the pelts of sea otter, and especially of fur seal, did not decrease much. This observation suggests that the severe increase in thermal conductance after oiling may be irreversible and that grooming after oiling will not cause a significant decrease in conductance.

Changes in conductance before and after oiling were not pronounced in the other seals and sea lion, which provides further evidence that in these species blubber rather than hair is responsible for providing insulation. Therefore, the effects of oiling on thermoregulatory function in these species is not as severe as that of sea otter and fur seal.

Activity: drilling; processing oil/gas; transport of oil/gas/water -- water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Marine Mammal Commission. 1986. Chapter VIII: Species of special concern. Pages 86-126 in Annual report of the Marine Mammal Commission, calendar year 1985. Marine Mammal Commission, Washington, D.C. 180 pp. (ADFG-F) *

The incidental take of sea otters in a nearshore halibut fishery off the coast of California is reported. The number of estimated deaths of sea otters caught in nearshore gill and trammel nets has varied from a low of 49 in 1973 to a maximum of 168 in 1981. In response to this incidental take, the California Department of Fish and Game closed waters in sea otter range within the 15-fathom (90 ft) depth curve to such net fishing; however, sea otter mortality continued to occur so the closure was expanded to within the 20-fathom (120 ft) depth curve. Although some incidental take offshore of the 20-fathom depth still occurs the closures have been considered successful.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Matkin, C.O., and F.H. Fay. 1980. Marine mammal - fishery interations on the Copper River and in Prince William Sound, Alaska, 1978. Report 78/07 to Marine Mammal Commission, Washington, D.C. 71pp. (abstract only) (HD)#

The rates of damage to netted fishes and to the nets themselves by marine mammals, and the rate of incidental catch of marine mammals were assessed in three salmon drift gill net fisheries through random sampling on the fishing grounds and by interview at dockside. Damages were most severe in the Copper River spring fishery where they were attributed mainly to Stellar sea lions and harbor seals. The latter accounted for most of the damages in the Coghill summer fishery and in the Copper-Bering River autumn fisheries. Approximately 1,000 marine mammals were killed in the process, half of which were harbor seals, 40% were sea lions, and the rest were sea otters and harbor and Dall porpoises. Damages tend to vary with size of catch, location, and time.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Rausch, R.L. 1983. Post mortem findings in some marine mammals and birds following the Canniken Test on Amchitka Island. Rept. by Arctic Health Research Center, Univ. Alaska-Fairbanks, for U.S. Atomic Energy Commission. 85 pp. (UAF)

This report discusses the effects of the underground nuclear test ("Canniken Test") detonated at Amchitka Island on 6 November 1971. Following the test, numerous dead and injured marine mammals and seabirds were found along the beach of the island. Four harbor seals and twelve sea otters were found that were in suitable condition for necropsy. Injuries to sea otters appeared to be from two sources: rocks falling from cliffs and injuring otters resting below, and a combination of over- and underpressures (hydrostatic pressure changes) resulting in rupture of lungs and other thoracic organs as well as damage to the central nervous system. Injuries and mortality of harbor seals appeared to be due only to hydrostatic changes.

Animals on the surface of the ocean appeared to escape severe injury, whereas animals underwater at the time of the blast were most susceptible. Overpressures of 200-300 psi were recorded within 5 km (3 mi) of the blast; overpressures of 100-200 psi were recorded in a zone an additional 3.5 km (2 mi) beyond the near zone.

Activity: blasting.

Impact: shock waves (increase in hydrostatic pressure).

Siniff, D.B., T.D. Williams, A.M. Johnson, and D.L. Garshelis. 1982. Experiments on the response of sea otters _Enhydra lutris_ to oil contamination. Biol. Conserv. 23:261-272. (UAF)*

Two sets of experiments on the effects of Prudhoe Bay crude oil contamination of Prince William Sound sea otters were conducted from 1977 to 1979. In one set of experiments radio-tagged sea otters were artificially contaminated with 25 cc of crude oil spread on their pelage, and the otters were then released to the wild where their activity was monitored for several weeks. In the other set of experiments two sea otters were released into a swimming pool that was partly covered with crude oil, and their subsequent behavior was monitored.

The sea otters released to the wild after oil fouling showed greatly increased activity rates (mostly grooming) for the first week after release, and gradually assumed a normal activity pattern until their activity became relatively normal by the end of the third week after release. The authors emphasized that although total daily activity increased markedly, the amount of time spent feeding remained at normal levels presumably because food is very abundant in Prince William Sound and the otters could compensate for their increased energy needs without additional feeding time. The authors speculated that in areas where the sea otter population was denser and/or food supplies more limited, the effects of oil contamination would be greater because the increased time the animals spent grooming would interfere with the time required for feeding and the animals would die from hypothermia or starvation.

In the second set of experiments both otters attempted to avoid the side of the pool with crude oil on the surface, but gradually as they swam in the pool their fur became contaminated. Both otters were removed from the pool and one otter was washed with a detergent and the other was not. The otter that was not washed died of hypothermia within 11 h. After being washed with detergent, the other otter was released into a clean pool; however, its pelage became saturated immediately and it was removed, dried, and kept in a dry facility for a day. It was then radio-tagged and released but its radio failed immediately so its fate is unknown. The authors note that cleaning oiled otters with a detergent removes the otter's natural oil as well as the crude oil, thus rendering the animal unable to maintain its body temperature. The authors urge the development of a detergent that will remove only crude oil and not the otter's natural oil.

Activity: drilling; processing oil/gas; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

8. Steller Sea Lion

Table 1. Impacts Associated With Each Activity - Steller sea lion

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source	?		?	?			?	?		?									?	?	?	X				?		?	?	
Barriers to movement, physical and behavioral	?		?				?	?		?				?	?		?	?	?	?	?				?	?	?	?	?	
Collision with vehicles or structures			?				?	?		?					?		?	?	?	?						?			?	
Entanglement in fishing nets, debris			?				?	?		?					?	X	?	?	?	?		?				?			?	
Entrapment in impoundments or excavations	?		?				?										?									?		?		
Harassment, active or passive	X		?				?	?		?				?	?		?	?	?	?	?	?			?	?	X	?	X	
Harvest, change in level			?				?	?		?				?	?		?	?	?	?	?	?					?	?	?	
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum			?	X			?	?												?					?	?	?	?	?	
Parasitism/predation, increased susceptibility	?		?	?			?	?		?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Prey base, alteration of	?		?	?			?	?		?				?	?		?	?	?	?	?	?			?	?	?	?	?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?		?				?																							
Veg. composition, change to less preferred																														
Veg. damage/destruction due to air pollution																														
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion																														
Water level or water quality fluctuations																														

X - Documented impact (see text).
? - Potential impact.

8. STELLER SEA LION - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on Steller sea lions. Each citation refers to an annotation in the following section, Annotated References to Impacts on Steller Sea Lions. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to Steller sea lion are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to Steller sea lion were found for the following activities:

Burning
Channelizing waterways
Clearing and tree harvest
Draining
Dredging
Drilling
Fencing
Filling and pile-supported structures (aquatic)
Filling (terrestrial)
Grading/plowing
Grazing
Human disturbance
Log storage/transport
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Processing oil/gas
Sewage disposal
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - land, ice
Transport of oil/gas/water - water
Transport of personnel/equipment/material - land, ice
Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Goertner 1982
      Hill 1978

   b. Shock waves (increase in hydrostatic pressure)

      Goertner 1982
      Hill 1978

2. Chemical application:

   a. Morbidity/mortality by ingestion of petroleum

      Gerlach 1981

3. Netting:

   a. Entanglement in fishing nets, debris

      Bonner 1978
      Everitt and Beach 1982
      Loughlin et al. 1983
      Matkin and Fay 1980
      Miller et al. 1983

4. Solid waste disposal:

   a. Attraction to artificial food source

      Loughlin et al. 1983

5. Transport of personnel/equipment/material - air:

   a. Harassment, active or passive

      Calkins 1983

6. Transport of personnel/equipment/material - water:

   a. Harassment, active or passive

      Calkins 1983

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to Steller sea lion were found for the following categories:

Aquatic substrate materials:
Attraction to artificial food source
Barriers to movement, physical and behavioral
Collision with vehicles or structures
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Aquatic vegetation, destruction or change:

   a. Solid waste disposal

      Loughlin et al. 1983

2. Entanglement in fishing nets, debris:

   a. Netting

      Bonner 1978
      Everitt and Beach 1982
      Loughlin et al. 1983
      Matkin and Fay 1980
      Miller et al. 1983

3. Harassment, active or passive:

   a. Blasting

Goertner 1982
Hill 1978

b. Transport of personnel/equipment/material - air

Calkins 1983

c. Transport of personnel/equipment/material - water

Calkins 1983

4. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Gerlach 1981

5. Shock waves (increase in hydrostatic pressure):

a. Blasting

Goertner 1982
Hill 1978

ANNOTATED REFERENCES TO IMPACTS TO STELLER SEA LIONS

The annotated bibliography contains only references that discuss documented impacts to Steller sea lions. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to Steller sea lions are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Bonner, W. 1978. Man's impact on seals. Mamm. Rev. 8(1/2):3-13. (UAF)#

The author reported generally on four human-caused impacts on seals: 1) incidental kill by commercial fisheries; 2) increasing mortality because of net fragments and ingestion of marine debris; 3) organochlorines pollution; and 4) increased levels of disturbance. Specific documented impacts to featured species in Alaska included mortality of northern fur seals and Steller sea lions incidental to commercial fishing operations. The author reported a direct annual kill of at least 7,000 northern fur seals caught in nets of Japanese commercial fishermen in the North Pacific, and 15,000 northern sea lions killed in nets annually.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Calkins, D. 1983. Marine mammals of Lower Cook Inlet and the potential for impact from Outer Continental Shelf oil and gas exploration, development, and transport. Pages 171-263 in Environmental assessment of the Alaskan continental shelf. Final reports of principal investigators. Vol. 20: Biological studies. USDC:NOAA. USDI:BLM. Anchorage. (HD)#

This report summarizes potential and documented impacts of oil and gas-related activities on marine mammals of lower Cook Inlet and Shelikof Straits area. Although most of the impacts that are discussed are potential rather than documented, the following documented impacts are presented:

(1) Oil pollution has caused morbidity and mortality in sea otters because of fouling of the otter's fur, upon which it relies to maintain thermoregulation.

(2) Oil pollution has also caused temporary blindness in grey seals (related to harbor seals), and damage to the eyes and kidneys of ringed seals (also related to harbor seals).

(3) Low-level flights by aircraft over harbor seal and Steller sea lion rookeries and haulouts have resulted in harassment. Animals have stampeded off the rookeries or haulouts; however, the responses varied with the environmental conditions (e.g., weather, sea state) as well as characteristics of the approaching aircraft.

    The author also reported that a twin engine airplane flying 300 m (1,000 ft) above a group of belukha whales caused the animals to retreat to deep water.

(4) Human ground traffic (e.g., hikers, all-terrain vehicles) caused the abandonment of haulouts of Steller sea lion in California, and haulouts of harbor seals and Steller sea lions in another undisclosed location.

    Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

    Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Everitt, R.D., and R.J. Beach. 1982. Marine mammal-fishery interactions in Oregon and Washington: an overview. Pages 265-277 in K. Sabol, ed. Transactions of the forty-seventh North American wildlife and natural resources conference. Wildlife Management Institute: Washington, DC. 722 pp. (UAF)

The authors reviewed the interactions of marine mammals and the nearshore commercial and recreational fisheries of Washington and Oregon. Marine mammals were observed to affect fisheries by destroying gear (e.g., nets, line) and stealing or ruining fish caught in nets or on lines. Fisheries affected marine mammals by entangling them in gear and causing injury or death, and by harassing animals at rookeries and haulouts so that seals have abandoned rookeries or haulouts.

Entanglement in gear primarily affects harbor seals because they tend to haul out in nearshore and estuarine areas where much of the best commercial and recreational fishing also occurs. A few Steller sea lions have also been killed by the nearshore fishery, but most sea lions have been taken in the offshore fishery.

Several Washington harbor seal haulouts were abandoned several decades ago because of intense human harassment, especially that associated with bounty hunting which was legal at the time. Currently, although harbor seals are no longer hunted most large haulouts are located in areas remote from human disturbance.

Current research efforts towards mitigation of the impact of entanglement are oriented towards the development of nonlethal methods (e.g., acoustical scaring devices) for keeping seals and sea lions away from actively fishing boats.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Gerlach, S. 1981. Marine pollution: Diagnosis and therapy. Springer-Verlag, New York. 217 pp. (UAF)#

Reproductive performance of the California sea lion was altered in the 1960's due to stillbirths linked with DDT contamination. Ongoing monitoring of the population has revealed that even years after the ban on DDT, stillbirths are still occurring and are linked with elevated levels of PCB and mercury in the same animals which have a high DDT concentration.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Goertner, J. 1982. Prediction of underwater explosion safe ranges for sea mammals. Rept. NSWC 82-188 of the U.S. Navy Surface Weapons Center. 25 pp. (ADF&G-F, Habitat)

This report describes a method for the prediction of the range from an underwater explosion at which significant injuries to marine mammals may occur. The method is based on an approximate scaling of underwater explosion test data developed using live sheep, dogs, and monkeys. Ranges are given for 20- and 55-ft (6.1 and 16.8 m) whales and for manatees and dolphins, although all ranges are by extrapolation from terrestrial mammals. The injury contours were developed for lung and intestinal injuries; the final injury contour was determined by taking the most sensitive of the two. For example, if a 1,200 lb charge exploded at a depth of 125 ft (38.1 m), the horizontal range of "slight" injury to 20- and 55-ft (6.1 and 16.8 m) whales at a depth of 150 ft (45.7 m) are, respectively, ±1,700 ft (518.3 m) and ±900 ft (274.4 m). The range of injury mainly varies with the depth and body size of the whales and the depth and size of the explosion. The modifying effects of water depth, bottom type, and surface reflection of shock waves are not considered. See also Hill (1978) for more data on the effects of underwater explosions.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Hill, S. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Pacific Mar. Sci. Rept. 78-26. Unpubl. MS. Institute of Ocean Science, Sidney, B.C. 50 pp. (ADF&G-F, Habitat)

This report provides an excellent summary of the properties of underwater explosions, including high explosives and air guns; the effects of shock waves on marine mammals and fish; and methods to eliminate or mitigate these effects. This is one of the few reports containing sufficient information to allow one to design a blasting program to minimize damage to fish or marine mammals or to determine the effects that may be anticipated from the blasting program when the specific design of that program is unknown.

Details are given for predicting the damage zone using the Shock Wave Impulse method, determined by the author to be the best method available. The method underestimates lethal ranges if the water is less than five times either target or detonation depth (whichever is greater) and the bottom is rocky or if the charge is detonated under thick ice; under such conditions, Hill recommends doubling the calculated distances. An impulse level of 0.34 bar-m sec is safe and should not result in injuries to mammals diving beneath the water surface; one of 0.69 bar-m sec will result in a low incidence of "trivial blasting injuries" and no ruptured eardrums; 1.38 bar-m sec gives a high incidence of slight blast injuries, including eardrum rupture, but animals should recover on their own; and an impulse level of 2.76 bar-m sec, although not resulting in mortality, would give a high incidence of moderately severe blast injuries, but the animals should still recover on their own. Impulse levels were calculated using land mammals submerged in water; marine mammals are probably less vulnerable to gross shock-wave damage although impulse levels at which hearing may be damaged are unknown, especially for toothed whales.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

Loughlin, T.R., L. Consiglieri, R.L. DeLong, and A.T. Actor. 1983. Incidental catch of marine mammals by foreign fishing vessels, 1978-81. Mar. Fish. Rev. 45(7-8-9):45-47. (UAF)

This report summarizes the incidental catch of marine mammals as observed by U.S. fishery observers aboard foreign (mostly Soviet and Japanese) fishing vessels within the U.S. 200 mile limit between 1978-1981. Of the total 298 marine mammals observed, 217 were dead and 81 were released alive. Northern sea lions comprised 90% of the incidental take; harbor seals comprised less than 1%. Most of the northern sea lions were not taken near rookeries. The authors attribute the high incidental take of the northern sea lions to the fact that sea lions have learned to follow fishing vessels to eat discarded fish offal, thus placing them in danger of being entangled in gear. This characteristic has also resulted in sea lions changing their pelagic distribution somewhat - prior to the 1960's, most sea lions in the Gulf of Alaska-Bering Sea remained within 18 km (15 mi) of shore. With the advent of an extensive offshore commercial fishery however, the occurrence of sea lions near vessels far offshore is commonplace.

Groundfish trawlers account for most of the incidental take, although some immature sea lion, fur seals, and harbor seals are taken in herring and salmon gill nets.

Activity: netting; solid waste disposal.

Impact: attraction to artificial food source; entanglement in fishing nets, marine or terrestrial debris, or structures.

Matkin, C.O., and F.H. Fay. 1980. Marine mammal - fishery interations on the Copper River and in Prince William Sound, Alaska, 1978. Report 78/07 to Marine Mammal Commission, Washington, D.C. 71 pp. (abstract only) (HD) #

The rates of damage to netted fishes and to the nets themselves by marine mammals, and the rate of incidental catch of marine mammals were assessed in three salmon drift gill net fisheries through random sampling on the fishing grounds and by interview at dockside. Damages were most severe in the Copper River spring fishery where they were attributed mainly to Stellar sea lions and harbor seals. The latter accounted for most of the damages in the Coghill summer fishery and in the Copper-Bering River autumn fisheries. Approximately 1,000 marine mammals were killed in the process, half of which were harbor seals, 40% were sea lions, and the rest were sea otters and harbor and Dall porpoises. Damages tend to vary with size of catch, location, and time.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Miller, D.J., M.J. Herder, and J.P. Scholl. 1983. California marine mammal-fishery interaction study, 1979-1981. Rept. to NMFS by Southwest Fisheries Center, La Jolla, CA. Contract #79-ABC-00149. 233 pp. (ADFG-G, Fairbanks)

This field research study in California documented the losses of commercial and sport fish taken by marine mammals, and the injury and mortality of marine mammals caught in commercial and recreational fishing gear.

The largest number of marine mammals of species relevant to Alaska that were caught in a 2-yr period included 1,900 California sea lions and 117 harbor seals. There were no documented losses of northern sea lions, although they were present in the area. The most numerous losses of marine mammals occurred in the shark drift and gill net fishery where more than half of the California sea lion mortality occurred. Harbor seal mortality was a problem only with the ocean gill net fishery, where 100 seals were taken. Other types of fisheries appear to be little problem to harbor seals because the seals either avoid the gear, or the fishery occurs in areas farther offshore or otherwise away from harbor seal habitat.

The authors also report other observations of human-induced effects on harbor seals. In 1979, dogs killed over 20 newborn seal pups at a rookery near Cypress Point, Monterey County. Human disturbance at the Double Point haulout at Pt. Reyes National Seashore resulted in the NPS restricting human access to that area. An historically large haulout at Strawberry Spit in San Francisco Bay is not utilized during the day because of human disturbance by boat and pedestrian traffic. The few animals now using the haulout do so only at night-time high tide.

Most measures to reduce the number of sea lions and harbor seals taken during the fisheries have failed. Acoustical deterrents, either explosive or electronic, had not satisfactorily worked as of 1983. Closing fishing areas around haulouts is one possible mitigating measure, but likely would not work in California where the best fishing grounds coincide with seal and sea lion haulouts.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

9. Brown Bear

Table 1. Impacts Associated With Each Activity - Brown bear

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove	?		?			?	?			?												?								
Aquatic vegetation, destruction or change	?		?	?		?	?			?								?	?	?	?	?								?
Attraction to artificial food source								?					X	X								X			X					
Barriers to movement, physical and behavioral					X				?			?													?			?	?	?
Collision with vehicles or structures																												X	?	
Entanglement in fishing nets, debris									?																					
Entrapment in impoundments or excavations												?													?					?
Harassment, active or passive	X		?		X		?	X		?	?	X	X	X	?		?	?	?	?	X				X		X	X	?	
Harvest, change in level					X								X	X														X		
Introduced wild/domestic species, competition													X																	
Morbidity/mortality by ingestion of petroleum																			?	?					?					
Parasitism/predation, increased susceptibility																														
Prey base, alteration of														X																?
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction						?	?					X										?								?
Veg. composition, change to less preferred		X	?	?	X	?	?			?	?	X	X	X	?						?									?
Veg. damage/destruction due to air pollution				?														?	?	?										
Veg. damage/destruction due to fire/parasitism		X			?																									
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion					X							X	?		?							?								
Water level or water quality fluctuations					?	?	?			?					?															?

X - Documented impact (see text).
? - Potential impact.

9. BROWN BEAR - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on brown bears. Each citation refers to an annotation in the following section, Annotated References to Impacts on Brown Bear. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to brown bear are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to brown bear were found for the following activities:

Channelizing waterways
Chemical application
Draining
Dredging
Filling and pile-supported structures (aquatic)
Filling (terrestrial)
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Processing oil/gas
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - water
Transport of personnel/equipment/material - water
Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Hanley et al. 1981
      Reynolds et al. 1983

2. Burning:

   a. Veg. composition, change to less preferred

      Martin 1983
      Zager et al. 1983

   b. Veg. damage/destruction due to fire/parasitism

      Martin 1983
      Zager et al. 1983

3. Clearing and tree harvest:

   a. Barriers to movement, physical and behavioral

      Archibald 1983
      Sigman 1985
      Zager et al. 1983

   b. Harassment, active or passive

      Elgmork 1976
      Elgmork 1978
      Mace and Jonkel 1980
      Sigman 1985
      Zager 1980
      Zager and Jonkel 1983

   c. Harvest, change in level

      Archibald 1983

   d. Veg. composition, change to less preferred

      Martin 1983
      Sigman 1985
      Zager and Jonkel 1983
      Zager et al. 1983

   e. Veg. damage/destruction due to erosion

      Elgmork 1976
      Martin 1983
      Mealey et al. 1977
      Sigman 1985
      Zager and Jonkel 1983
      Zager et al. 1983

4. Drilling:

   a. Harassment, active or passive

      Hanley et al. 1981
      Harding and Nagy 1980
      Pearson 1980
      Reynolds et al. 1983
      Schallenberger 1980
      Zager and Jonkel 1983

5. Fencing:

   a. Barriers to movement, physical and behavioral

      Bromley 1985
      Follmann and Hechtel 1983
      Follmann et al. 1980

6. Grading/plowing:

   a. Harassment, active or passive

      Elgmork 1976
      Elgmork 1978
      Elgmork 1983
      Harding and Nagy 1980
      Milke 1977
      Schallenberger 1980
      Schoen et al. 1985
      Sigman 1985

   b. Terrain alteration or destruction

      Harding and Nagy 1980
      Pearson 1980
      Zager and Jonkel 1983

   c. Veg. composition, change to less preferred

      Martin 1983
      Sigman 1985

   d. Veg. damage/destruction due to erosion

      Elgmork 1976
      Martin 1983
      Schallenberger 1980

Zager and Jonkel 1983
Zager et al. 1983

7. Grazing:

   a. Attraction to artificial food source

      Camarra 1983
      Claar et al. 1983
      Eide 1965
      Griffel 1982
      Hoak et al. 1983
      Jonkel 1980
      Jorgensen 1983
      Klebesadel and Restad 1981
      Knight and Judd 1983
      Lentfer et al. 1968
      Lentfer et al. 1969
      Schallenberger 1980
      Zager and Jonkel 1983

   b. Harassment, active or passive

      Jonkel 1980
      Zager and Jonkel 1983

   c. Harvest, change in level

      Eide 1965
      Griffel 1982
      Jonkel 1980
      Jorgensen 1983
      Lentfer et al. 1968
      Lentfer et al. 1969

   d. Introduced wild/domestic species, competition

      Jonkel 1980
      Jorgensen 1983
      Mealey et al. 1977
      Schallenberger 1980
      Zager and Jonkel 1983

   e. Veg. composition, change to less preferred

      Jonkel 1980
      Jorgensen 1983
      Schallenberger 1980
      Zager and Jonkel 1983

f. Veg. damage/destruction due to grazing

Jonkel 1980
Jorgensen 1983
Zager and Jonkel 1983

8. Human disturbance:

a. Attraction to artificial food source

Bromley 1985
Craighead and Craighead 1972
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1980
Herrero 1985
Milke 1977

b. Harassment, active or passive

Chester 1980
Claar et al. 1983
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Douglass et al. 1980
Elgmork 1976
Elgmork 1978
Elgmork 1983
Faro and Eide 1974
Follmann and Hechtel 1983
Follmann et al. 1980
Geist 1978
Hanley et al. 1980
Harding and Nagy 1980
Herrero 1970
Herrero 1976
Herrero 1982
Herrero 1985
Hoak et al. 1983
Jope 1983
Knight and Judd 1983
Linderman 1974
Marsh 1972
Martinka 1976
McArthur-Jope 1983
McCullough 1982
Merrill 1978

Milke 1977
Miller 1983
Mundy and Flook 1973
Schallenberger 1980
Sigman 1985
Smith and Van Daele 1984
Tracy 1977
Zager 1980
Zager and Jonkel 1983

c. Harvest, change in level

Bromley 1985
Claar et al. 1983
Cole 1972
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Follmann and Hechtel 1983
Follmann et al. 1980
Herrero 1982
Herrero 1985
Hoak et al. 1983
Knight and Judd 1983
Marsh 1972
McCullough 1982
Milke 1977
Sigman 1985
Smith and Van Daele 1984
Zager and Jonkel 1983

d. Prey base, alteration of

Schallenberger 1980

e. Veg. composition, change to less preferred

Martinka 1976
Schallenberger 1980
Zager and Jonkel 1983

9. Sewage disposal:

a. Harassment, active or passive

Harding and Nagy 1980

10. Solid waste disposal:

a. Attraction to artificial food source

Archibald 1983
Bromley 1985
Chester 1980
Cole 1972
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1980
Herrero 1970
Herrero 1976
Herrero 1982
Herrero 1985
Hoak et al. 1983
Jonkel 1980
Marsh 1972
McCullough 1982
Merrill 1978
Milke 1977
Mundy and Flook 1973
Schallenberger 1980
Sigman 1985
Smith and Van Daele 1984
Zager and Jonkel 1983

11. Transport of oil/gas/water - land, ice:

a. Attraction to artificial food source

Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1981
Milke 1977

b. Harassment, active or passive

Follmann and Hechtel 1983
Follmann et al. 1980
Milke 1977
Schallenberger 1980

12. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Doll et al. 1974
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Garner et al. 1983
Harding and Nagy 1980
Klein 1973
Linderman 1974
McCourt et al. 1974
Milke 1977
Quimby 1974
Reynolds et al. 1976
Reynolds et al. 1983
Schallenberger 1980
Schoen et al. 1985
USDI 1976a

13. Transport of personnel/equipment/material - land, ice:

a. Collision with vehicles or structures

Marsh 1972
Milke 1977

b. Harassment, active or passive

Douglass et al. 1980
Elgmork 1976
Elgmork 1983
Follmann and Hechtel 1983
Follmann et al. 1980
Harding and Nagy 1980
Milke 1977
Schallenberger 1980
Smith and Van Daele 1984
Stelmock 1981
Tracy 1977
Zager 1980
Zager and Jonkel 1983

c. Harvest, change in level

Archibald 1983

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to brown bear were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Morbidity/mortality by ingestion of petroleum
Parasitism/predation, increased susceptibility
Shock waves (increase in hydrostatic pressure)
Veg. damage/destruction due to air pollution
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

a. Grazing

Camarra 1983
Claar et al. 1983
Eide 1965
Griffel 1982
Hoak et al. 1983
Jonkel 1980
Jorgensen 1983
Klebesadel and Restad 1981
Knight and Judd 1983
Lentfer et al. 1968
Lentfer et al. 1969
Schallenberger 1980
Zager and Jonkel 1983

b. Human disturbance

Bromley 1985
Craighead and Craighead 1972
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1980
Herrero 1985
Milke 1977

c. Solid waste disposal

Archibald 1983
Bromley 1985
Chester 1980
Cole 1972
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1980
Herrero 1970
Herrero 1976
Herrero 1982
Herrero 1985
Hoak et al. 1983
Jonkel 1980
Marsh 1972
McCullough 1982
Merrill 1978
Milke 1977
Mundy and Flook 1973
Schallenberger 1980
Sigman 1985
Smith and Van Daele 1984
Zager and Jonkel 1983

d. Transport of oil/gas/water - land, ice

Follmann and Hechtel 1983
Follmann et al. 1980
Hanley et al. 1981
Milke 1977

2. Barriers to movement, physical and behavioral:

a. Clearing and tree harvest

Archibald 1983
Sigman 1985
Zager et al. 1983

b. Fencing

Bromley 1985
Follmann and Hechtel 1983
Follmann et al. 1980

3. Collision with vehicles or structures:

   a. Transport of personnel/equipment/material - land, ice

      Marsh 1972
      Milke 1977

4. Harassment, active or passive:

   a. Blasting

      Hanley et al. 1981
      Reynolds et al. 1983

   b. Clearing and tree harvest

      Elgmork 1976
      Elgmork 1978
      Mace and Jonkel 1980
      Sigman 1985
      Zager 1980
      Zager and Jonkel 1983

   c. Drilling

      Hanley et al. 1981
      Harding and Nagy 1980
      Pearson 1980
      Reynolds et al. 1983
      Schallenberger 1980
      Zager and Jonkel 1983

   d. Grading/plowing

      Elgmork 1976
      Elgmork 1978
      Elgmork 1983
      Harding and Nagy 1980
      Milke 1977
      Schallenberger 1980
      Schoen et al. 1985
      Sigman 1985

   e. Grazing

      Jonkel 1980
      Zager and Jonkel 1983

   f. Human disturbance

Chester 1980
Claar et al. 1983
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Douglass et al. 1980
Elgmork 1976
Elgmork 1978
Elgmork 1983
Faro and Eide 1974
Follmann and Hechtel 1983
Follmann et al. 1980
Geist 1978
Hanley et al. 1980
Harding and Nagy 1980
Herrero 1970
Herrero 1976
Herrero 1982
Herrero 1985
Hoak et al. 1983
Jope 1983
Knight and Judd 1983
Linderman 1974
Marsh 1972
Martinka 1976
McArthur-Jope 1983
McCullough 1982
Merrill 1978
Milke 1977
Miller 1983
Mundy and Flook 1973
Schallenberger 1980
Sigman 1985
Smith and Van Daele 1984
Tracy 1977
Zager 1980
Zager and Jonkel 1983

g. Sewage disposal

Harding and Nagy 1980

h. Transport of oil/gas/water - land, ice

Follmann and Hechtel 1983
Follmann et al. 1980
Milke 1977
Schallenberger 1980

i. Transport of personnel/equipment/material - air

Doll et al. 1974
Douglass et al. 1980
Follmann and Hechtel 1983
Follmann et al. 1980
Garner et al. 1983
Harding and Nagy 1980
Klein 1973
Linderman 1974
McCourt et al. 1974
Milke 1977
Quimby 1974
Reynolds et al. 1976
Reynolds et al. 1983
Schallenberger 1980
Schoen et al. 1985
USDI 1976a

j. Transport of personnel/equipment/material - land, ice

Douglass et al. 1980
Elgmork 1976
Elgmork 1983
Follmann and Hechtel 1983
Follmann et al. 1980
Harding and Nagy 1980
Milke 1977
Schallenberger 1980
Smith and Van Daele 1984
Stelmock 1981
Tracy 1977
Zager 1980
Zager and Jonkel 1983

5. Harvest, change in level:

a. Clearing and tree harvest

Archibald 1983

b. Grazing

Eide 1965
Griffel 1982
Jonkel 1980
Jorgensen 1983
Lentfer et al. 1968
Lentfer et al. 1969

c. Human disturbance

Bromley 1985
Claar et al. 1983
Cole 1972
Cowan 1972
Craighead and Craighead 1972
Craighead et al. 1976
Follmann and Hechtel 1983
Follmann et al. 1980
Herrero 1982
Herrero 1985
Hoak et al. 1983
Knight and Judd 1983
Marsh 1972
McCullough 1982
Milke 1977
Sigman 1985
Smith and Van Daele 1984
Zager and Jonkel 1983

d. Transport of personnel/equipment/material - land, ice

Archibald 1983

6. Introduced wild/domestic species, competition:

a. Grazing

Jonkel 1980
Jorgensen 1983
Mealey et al. 1977
Schallenberger 1980
Zager and Jonkel 1983

7. Prey base, alteration of:

a. Human disturbance

Schallenberger 1980

8. Terrain alteration or destruction:

a. Grading/plowing

Harding and Nagy 1980
Pearson 1980
Zager and Jonkel 1983

9. Veg. composition, change to less preferred:

   a. Burning

      Martin 1983
      Zager et al. 1983

   b. Clearing and tree harvest

      Martin 1983
      Sigman 1985
      Zager and Jonkel 1983
      Zager et al. 1983

   c. Grading/plowing

      Martin 1983
      Sigman 1985

   d. Grazing

      Jonkel 1980
      Jorgensen 1983
      Schallenberger 1980
      Zager and Jonkel 1983

   e. Human disturbance

      Martinka 1976
      Schallenberger 1980
      Zager and Jonkel 1983

10. Veg. damage/destruction due to fire/parasitism:

   a. Burning

      Martin 1983
      Zager et al. 1983

11. Veg. damage/destruction due to grazing:

   a. Grazing

      Jonkel 1980
      Jorgensen 1983
      Zager and Jonkel 1983

12. Veg. damage/destruction due to erosion:

a. Clearing and tree harvest

Elgmork 1976
Martin 1983
Mealey et al. 1977
Sigman 1985
Zager and Jonkel 1983
Zager et al. 1983

b. Grading/plowing

Elgmork 1976
Martin 1983
Schallenberger 1980
Zager and Jonkel 1983
Zager et al. 1983

ANNOTATED REFERENCES TO IMPACTS TO BROWN BEARS

The annotated bibliography contains only references that discuss documented impacts to brown bears. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to brown bears are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Archibald, W.R. 1983. Problem analysis: grizzly bears and coastal development, with particular reference to intensive forestry. Fish and Wildl. Bull. No. B-26. Ministry of Environment, Victoria, British Columbia. 24 pp. (UAF)

This review paper describes the management concerns and research needs relating to coastal brown bears and intensive forestry in British Columbia, Canada. Studies reviewed were conducted primarily during the 1970's and early 1980's in Alaska, Canada, and the northern United States. Habitat within the area of concern (British Columbia) ranges from dense coastal forest to muskeg areas and alpine tundra. Habitat types for each reviewed study were not provided, although most reviewed studies were conducted in interior areas, well away from coastal forests. The activities of clearing and tree harvest and log storage and transport could produce potential indirect impacts of vegetation composition change to less preferred or useable species, water level fluctuations, and vegetation damage/destruction due to contact with chemicals. Logging activities could have indirect effects on bears by altering existing water regimes, which could alter the composition or productivity of sedge/carex meadows and skunk cabbage sites, important spring feeding areas for bears. The placement of camps and booming grounds in esturarine areas could also affect the sedge/carex meadows and skunk cabbage sites. Herbicides used to encourage seedling production could eliminate berry plants used by bears. The activity of clearing and tree harvest also produced a documented direct impact of barriers to movement. Bears were observed moving through slash areas with great difficulty and, in a hunted population, avoiding slash and other open areas and moving through protective unlogged forest cover. The activities of transporting personnel/equipment/material by land and clearing and tree harvest produced a documented indirect impact of change in level of harvest. Increased access via logging roads has led to a greater harvest of bears from legal and illegal hunting. The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source. Bears were commonly attracted to logging camp garbage dumps, requiring that bears be relocated or destroyed. A list of informational needs concerning bear biology and the effects of tree harvest on bears is presented.

Activity: clearing and tree harvest; solid waste disposal; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; harvest, change in level.

Bromley, M. 1985. Safety in bear country: a reference manual. Northwest Territories Dept. Renewable Resources, Yellowknife. (ADF&G-F, Habitat)*

This report provides an excellent summary of measures to avoid or reduce bear-human encounters that often result in human injury, destruction of property, and death of bears. This report was written to address bear-human problems encountered in the Northwest Territories, Canada; however, much of the information presented is applicable to Alaskan situations. Information on bear biology and behavior is presented for black, brown and polar bears, including examples of bear-human encounters. Topics discussed in detail include bear detection systems for camps, camp design and maintenance, and deterance methods for personnel and facilities. The activities of human disturbance, and solid waste disposal produced documented impacts of attraction to an artificial food source and an increase in harvest. Bears were attracted to improperly handled food and garbage and many were then shot in "defense of life and property."

Activity: fencing; human disturbance; solid waste disposal.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; harvest, change in level.

Camarra, J.J. 1983. Evolution of the brown bear predation on the livestock in pyreness. Paper presented at the sixth international conference on bear research and management. Bear Bio. Assoc. Grand Canyon, AZ. (ADF&G-F) #

Evidence of about 600 attacks by brown bears were collected by the rangers working in the Pyrenees National Park. Attacks were directed mostly against sheep, but also ranged from goats to, more rarely, cows. Such proofs of attacks were largely dispersed over about 1000 km^2 (386 mi^2) of mountainous area, slightly decreasing by an average of 25 km^2 (9.6 mi^2) per year, with great diversity from one site to another.

Activity: grazing.

Impact: attraction to artificial food source.

Chester, J.M. 1980. Factors influencing human-grizzly bear interactions in a back country setting. Pages 351-357 in C.J. Martinka and K.L. McArthur, eds. Bears - their biology and management. Fourth international conference on bear research and management, Kalispell, MT, February, 1977. Bear Biology Assoc. Conf. Ser. No. 3. (UAF)*

In this field research and questionnaire study, the interactions between brown bears of all life stages and humans in the Gallatin Range of northwestern Yellowstone National Park during the summers of 1973 and 1974 are described. Incidental observations of interactions between humans and black bear, coyote, mule deer, bighorn sheep, elk, and moose are also reported. The high elevation of the study area compensates for its latitude to result in habitat types similar to those present in Alaska: primarily coniferous forest with areas of alpine tundra and riparian zones. The activities of human disturbance and solid waste disposal were responsible for the direct documented impact of passive harassment and the potential direct impact of attraction to artificial food source. Passive harassment of brown bears was minimized by the fact that most human disturbance occurred on low-elevation forest trails during July and August, when bears were in the subalpine and alpine tundra zones. Grizzlies were more sensitive to disturbance (wary) than the other species studied. Behavior of humans in the back country that increased the potential for direct bear-human interactions included travel in groups of one or two persons (larger groups passively harassed bears at greater distances), use of fresh or canned food versus dried food, dumping or burial of excess food, not securing food at camp or securing it too close to camp (within 92-137 m [300-450 ft]), and off-trail travel. One mitigation guideline was suggested: prohibit camping at elevations above 2,591 m (8,500 ft), the lower limit of the spruce-subalpine fir zone.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Claar, J.J., R.W. Klaver, and C.W. Servheen. 1983. Grizzly bear management on the Flathead Indian Reservation, Montana. Paper presented at the sixth international conference on bear research and management. Bear Bio. Assoc. Grand Canyon, AZ. (ADF&G-A, Game)#

Grizzly bears (Ursus arctos horribilis) inhabit the Mission Range on the Flathead Indian Reservation in western Montana. Their spring/fall foraging brings them to low elevations (975m [3,200 ft]) where they have co-existed in a ranching economy since the 1900's. An objective of the 1981 Reservation Management Plan is to "manage the grizzly bear population so its trend is stable or slightly increasing." Human tolerance of grizzly bears in the Mission Valley is necessary for bear survival and population stability. Bears that prey on livestock are usually removed from the population. Circumstances of nine livestock depredations by grizzly bears were examined during 1960-1981 and it was found that both sexes, subadults and adults, were involved with depredation. There were at least two factors leading to livestock depredation and "problem" bear status: individual bear behavior and human environment.

Activity: grazing; human disturbance.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Cole, G.F. 1972. Preservation and management of grizzly bears in Yellowstone National Park. Pages 274-288 in S. Herrero, ed. Bears - their biology and management. IUCN Publ. New Series No. 23. Morges, Switzerland. (UAF)*

In this report and discussion of management of a wild grizzly bear population in Yellowstone National Park, Wyoming, between 1930 and 1970, information is presented about bears of all life stages. Although both the geographic area and habitat types are not equivalent to those used by brown bears in Alaska, seasonal use of habitat types is similar, and responses of bears to human activities are also expected to be similar. Habitat types include Rocky Mountain coniferous and aspen forest, alpine tundra, and riparian areas. The activities of human disturbance and solid waste disposal are responsible for documented direct impacts of attraction to artificial food source and change in harvest level. Conclusive results showed that bears learn to migrate to garbage dumps and other artificial food sources and that the human influence of artificial food was responsible for 95% of injuries to humans by bears in the last 40 years. Protection of cubs by sows was responsible for the remaining 5%. Management guidelines are as follows: 1) Remove all artificial food to avoid altering bear behavior, by fencing incinerators, moving landfills at least 13 km (8 mi) from developments and preferably outside of the park, publicizing and imposing fines on campers who allow bears to eat their food, converting camps in superior grizzly habitat to daytime use or fencing them, and installing bear-proof garbage cans. Artificial food sources should be removed abruptly to minimize the number of bears requiring removal. 2) Apply consistent preventative (pre-injury) removal of habituated bears from developed areas. 3) Remove problem bears from the park rather than transplanting them repeatedly in the park, once they are known to return, by donating to zoos, transplanting outside the park, or killing and donating the bodies to research. 4) Monitor the park for seasonal or temporary high bear concentration areas, and regulate hiking, camping, and campground use accordingly.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harvest, change in level.

Cowan, I.M. 1972. The status and conservation of bears (Ursidae) of the world - 1970. Pages 343-367 in S. Herrero, ed. Bears - their biology and management. IUCN Publ. New Ser. No. 23. Morges, Switzerland. (UAF) *

This review article primarily discusses the distribution and harvest management of bears throughout the world for as long as reliable records have existed. Brown bears in Alaska are discussed in brief. The activities of human disturbance and solid waste disposal are responsible for direct documented impacts of attraction to artificial food source, active and passive harassment, and change in harvest level. None of these are discussed in detail. Mitigation guidelines for parks and protected areas include the following: 1) remove all trash and garbage from access by bears, whether gradually or abruptly, depending on local circumstances; 2) educate the public and enforce regulations involving humans and their behavior; 3) protect campgrounds by means such as night patrols, drift fencing with electrified components, and closing or relocating campgrounds prone to trouble; 4) use means other than shooting to deter bears from campsites; 5) while phasing out access to trash and garbage, consider providing temporary food in remote areas (e.g., carcasses); and 6) transplant intractable bears to distances beyond 80 km (50 mi) for females and 160 km (100 mi) for males, to avoid returns.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Craighead, J.J. and F.C. Craighead, Jr. 1972. Grizzly bear-man relationships in Yellowstone National Park. Pages 304-332 in S. Herrero, ed. Bears - their biology and management. IUCN Publ. New Ser. No. 23. Morges, Switzerland. (UAF)*

In this report of a long-term field research project and its management implications, brown bears of all life stages were marked, equipped with radio transmitters, and observed during the summers of 1959 through 1970 in Yellowstone National Park, Wyoming. The high elevation and mountainous terrain in the park compensate for its southerly latitude compared to Alaska, resulting in analogous habitat types of coniferous and aspen forests, grasslands, riparian zones, and alpine tundra. The activities of human disturbance and solid waste disposal were responsible for documented direct impacts of attraction to artificial food source, passive and active harassment, and increase in harvest level. Conclusive results show that garbage dumps that have attracted grizzlies from within and outside the park during the summer months for the past 80 years are the ecological equivalent of salmon runs in Alaska, and essentially all brown bears feed at them, without losing their wariness for man at other locations. Most bears also accidentally encounter and feed on garbage and food at campgrounds, but few bears become habitual offenders (defined as four or more recaptures in campgrounds) and seek food in defiance of humans. The latter initially requires the cooperation and encouragement of man, usually through actively feeding bears. Garbage dumps effectively concentrated brown bears at the peak tourist season in areas with restricted public access. The abrupt closure of garbage dumps in 1968, like the abrupt closure of feeding stations in 1941, resulted in dispersal of grizzlies and a substantial increase in campground incidents. A five-fold increase in the grizzly dispatch (killing or sending to zoos) rate occurred in 1970. This removal rate is 3.5 times the average rate of natural increase in the park population of six per year. The problem of campground incidents was exacerbated by the fact that campgrounds had not been adequately sanitized prior to closure of the dumps. Mitigation guidelines are as follows: 1) reopen the dumps before phasing them out slowly to allow bears to adopt more natural feeding habits; 2) completely sanitize all developed areas and camps; 3) publicize and enforce regulations against visitors leaving any food in camps to attract animals; 4) dispatch only four-time offender bears rather than two-time offenders, as is done now; and 5) educate the visiting public to accept a small risk of grizzly injury (about 1: 900,000).

[Reviewer's note: This is a thorough, well thought out article. Guideline no. 4 is in partial conflict with Marsh (1972), who recommends rapid transplanting of bears found in campgrounds.]

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Craighead, J.J., F.C. Craighead, Jr., and J.S. Sumner. 1976. Reproductive cycles and rates in the grizzly bear, Ursus arctos horribilis, of the Yellowstone ecosystem. Pages 337-356 in M.R. Pelton, J.W. Lentfer, and G.E. Folk, eds. Bears - their biology and management. IUCN Publ. New Ser. No. 40. Morges, Switzerland. (UAF)

In this field research article, female brown bears of all life stages were studied from 1959 to 1971 in Yellowstone National Park, Wyoming. Although the study area is south of Alaska, the high elevation and mountainous terrain result in analogous habitat types of coniferous and aspen forests with meadows and riparian zones, open subalpine coniferous forests, and alpine tundra. The activities of human disturbance and solid waste disposal were responsible for the direct documented impacts of attraction to artificial food source, active harassment and change in harvest level, the probable direct impact of interference with reproductive behavior (closure of garbage dumps) and the potential direct impact of interference with reproductive behavior (immobilization drugs). Sows were immobilized from 1 to 17 times each, with no significant correlation between number of immobilizations and reproductive rate. A drop in the annual reproductive rate of the population can be related to the marked decrease in food supply associated with the abrupt closing of open-pit garbage dumps. The low reproductive rate and delayed maturity of brown bears combined with high mortality due to man's control (as in the Yellowstone system) and, potentially, excessive harvest, could lead to a rapid and irreversible decline in population size.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Doll, D., W.P. McCrory, and J.D. Feist. 1974. Observations of moose, wolf, and grizzly bear in the northern Yukon Territory. In K.H. McCourt and L.P. Horstman, eds. Studies of large mammal populations in northeastern Alaska, Yukon, and Northwest Territories, 1973. Arctic Gas Biol. Rept. Ser., Vol. 22, Chap. 3. (UAF)

This field study was conducted during the period March through November 1973 in conjunction with studies of the Porcupine Caribou Herd. Observations of 144 grizzly bears within the northern Yukon Territory were reported. In addition to distribution and population composition data, data on the reaction of bears to aircraft were presented. Grizzlies were sighted in mountainous terrain, spruce forests, stands of willow, and coastal tundra. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Reactions of individual bears to the aircraft varied substantially as it overflew the bears. Some bears reacted strongly to aircraft that overflew them at altitudes of 15 to 300 m (50 to 1,000 ft). Other bears showed little or no reactions to aircraft at altitudes of 90 to 300 m (300 to 1,000 ft).

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Douglass, R.J., J.M. Wright, S.G. Fancy, E.H. Follmann, and J.L. Hechtel. 1980. Assessment of the knowledge of potential effects of the Northwest Alaskan Pipeline Project on mammals: literature review and agency input. Final rept. Prepared by LGL Ecological Research Associates, Inc. and the Univ. Alaska for Northwest Alaskan Pipeline Company. 150 pp. (UAF)

This review paper examined published and unpublished data, government regulations and proposed stipulations, and agency comments dealing with selected mammal species found along the proposed Northwest Alaskan gas pipeline route in an attempt to avoid or minimize human-wildlife conflicts that have occurred on other projects or that have been observed elsewhere. References reviewed were primarily from northern North America and were written primarily during the 1970's. Species reviewed included brown and black bears, moose, caribou, Dall sheep, bison, wolves, coyotes, red and arctic foxes, furbearers, and small mammals. Specific habitat types were not described for each reviewed study.

Brown bear. The activity of transporting personnel/equipment/material by land and air produced documented direct impacts of active and passive harassment. Bears reacted to noise from both aircraft and vehicles and reacted strongly to hazing by vehicles and aircraft, particularly helicopters. The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source. Many cases are reported where bears are attracted to improperly handled garbage at camps, worksites, and dumps. The activity of human disturbance produced direct documented impacts of attraction to artificial food sources and active and passive harassment. Bears were often fed by workers at worksites, a particular problem during construction of the trans-Alaska oil pipeline. The activities of transporting oil/gas/water by land and grading and plowing can produce a potential impact of barriers to movement in the event that long sections of pipeline are left on the ground or long open trenches are present during pipeline construction.

Activity: human disturbance; solid waste disposal; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Eide, S.H. 1965. The nature of brown bear predation on cattle, Kodiak Island, Alaska. Proc. Annual Conf. Western Assoc. State Game Fish Comm. 45:113-118. (GDL) #

The relationship between brown bears and domestic cattle was studied on Kodiak Island, Alaska from May 1, 1964, through June 30, 1965, to provide information that might alleviate the conflict between the brown bears and the cattle industry. Primary considerations throughout the study were 1) the extent of bear predation on cattle, 2) sex and age composition of bears on the cattle ranges, and 3) the place of origin and patterns of movement of bears on the cattle ranges. During the study period, 15 brown bears were killed as predators or potential predators.

Activity: grazing.

Impact: attraction to artificial food source; harvest, change in level.

Elgmork, K. 1976. A remnant brown bear population in southern Norway and problems of its conservation. Pages 281-297 in M.R. Pelton, J.W. Lentfer, and G.E. Folk, eds. Bears - their biology and management. IUCN Publ. New Series No. 40. Morges, Switzerland. (UAF)*

In this field research paper, conditions associated with the decline of an isolated population of brown bears including individuals of all life stages in southern Norway between 1949 and 1973 are discussed. The latitude of the forests, subalpine slopes with avalanche tracks, and alpine tundra are very similar to those of southcentral Alaska. Much of the information consists of several hundred reports of bear sightings. The activities of clearing and tree harvest, grading/plowing, human disturbance, and transporting personnel/equipment/material by land were responsible for the documented direct impact of passive harassment, the documented indirect impact of vegetation damage or destruction due to mechanical removal, and the probable direct impact of barriers to movement. Conclusive results show that the decline in population size from an estimated 14 individuals in the mid 1950's to eight in 1973 was due neither to hunting nor to insufficient reproduction, but to habitat deterioration. Construction of forestry roads and clear-cutting of old spruce forests showed a strong negative correlation with bear sightings. Passive harassment from motor vehicles and humans on foot was associated with later development of recreational cabins. Roads, clear-cuts, and cabin concentrations may act as barriers to movement and interfere with reproductive behavior. Extension of logging into subalpine forests near known denning areas threatens essential habitat. Mitigation guidelines are 1) to prohibit holiday cabins in undisturbed core habitat and 2) to prohibit logging and road construction near denning areas.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Elgmork, K. 1978. Human impact on a brown bear population (*Ursus arctos* L.). Biol. Conserv. 13(2):81-103. (ARL)#

This study looked at the effect of human activity on a remnant brown bear population in southern Norway over 25 years. Bear reports were compared with indices of human activity, primarily the building of a forest road network and clear-cutting. Forest road density was used as an indicator of human impact. The number of bear observations was negatively correlated with forest road density and positively correlated with length of timberline in an area. Negative tendencies were also indicated in areas close to cabin concentrations. The author feels this effect may be more visible later, as extensive building of cabins has occurred only in the last 10 years. A theoretical model is developed and supported by field observations, relating bear observations, timberline, and roads.

Activity: clearing and tree harvest; grading/plowing; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Elgmork, K. 1983. Influence of holiday cabin concentrations on the occurrence of brown bears (Ursus arctos L.) in southcentral Norway. Acta. Zool. Fennica 174:161-162. (UAF)

The author related observations of brown bears to concentrations of holiday cabins in central south Norway for the period 1949-1978. The study area is similar in latitude to that of portions of Alaska. No description of habitat was provided in the article. The purpose of this review/field study was to document the apparent decline in the number of bear observations and thus bear occurrence in and near populated areas. The activities of human disturbance, grading/plowing, and transporting personnel/equipment/material by land produced a documented direct impact of passive harassment. The percentage of bear observations within the cabin and cabin influence zones (a 2 km [1.25 mi] area surrounding concentrations of cabins) declined slowly from 1949 to the mid 1960's and was associated with increased human presence associated with summer farming and increased traffic with the building of forestry roads. A greater decline in the number of observations within the cabin and cabin influence zones occurred from the mid 1960's to the mid 1970's concurrent with the construction of about 1,200 cabins (a three-fold increase). The author emphasized that the reduction in bear observations ran counter to the increased number of cabins and the increased chance of discovery of bears; therefore, a negative influence on bear occurrence near concentrations of cabins was due to increased human disturbance and changes in the local environment.

Activity: grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Faro, J.B., and S.H. Eide. 1974. Management of McNeil River State Game Sanctuary for nonconsumptive use of Alaskan brown bears. Proc. West. Assoc. State Game and Fish Comm. 54:113-118. (GDL)#

An increase in numbers of visitors attempting to photograph bear concentrations at waterfalls on the McNeil River caused bear-human conflicts. Activity patterns and tolerance of bears changed in response to increasing human disturbance. Bears left the falls as people arrived, gradually returned as people settled, and left again as visitors departed. Heaviest use by bears occurred in the evening in the absence of humans. With light disturbance, bears tended to use the falls all day. Evidence of abandonment of the area by bears is indicated. In previous years, bears had appeared quite tolerant of infrequent human activity. As visitor numbers increased, bears entered camps more often and showed tolerance only if human activities remained within previously established patterns.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Follmann, E.H., and J.L. Hechtel. 1983. Bears and pipeline construction in the far north. Draft paper presented at the sixth international conference on bear research and management. Bear Biol. Assoc. Grand Canyon, AZ. (ADF&G-F, Habitat)*

This paper reviewed the problems that developed between humans and carnivores during construction of the trans-Alaska oil pipeline system (TAPS) during the mid 1970's. Bears, both brown and black, and their interactions with humans were described in particular detail, while interactions involving wolves or foxes were briefly discussed. Locations of human-carnivore interactions ranged from Prudhoe Bay to Valdez and encompassed habitat ranging from coastal coniferous forest to arctic tundra. Two particular problem areas were located in coniferous forest and in shrub and alpine tundra. The activities of fencing, human disturbance, solid waste disposal, transport of personnel by land and air, and transport of oil by land produced documented direct impacts of attraction to an artificial food source, barriers to movement, active harassment, and increase in level of harvest. A combination of inadequate garbage handling, animal feeding, and lack of fences around construction camps north of the Yukon River created numerous animal problems. The feeding of bears by workers within the construction camps and at work sites was common. Bears also were attracted to camps and dumps because of improperly collected, stored, incinerated, or buried garbage. Litter along work sites also contributed to the attraction of bears to these areas. Bears, particularly black bears, also sought shelter under camp buildings. Trucks, helicopters, firecrackers, and crackershells were used to chase bears away from work sites and camps. Problem bears (those that had directly threatened people or were determined incorrigible) were shot if all other means were insufficient to chase them from the area.

Two small 100-person camps, occupied primarily during the summer by personnel connected with survey and study functions of the proposed Northwest Alaska gas pipeline project, were surrounded by electrified fences designed to deter animal entry (see Follmann et al. 1980 for additional information on fence design). One camp was north of the Yukon River (5-Mile Camp) where black bears had been a particular problem during TAPS, and the other was near the divide of the Brooks Range (Chandalar Camp), where brown bears had been a particular problem during TAPS. During the summers of 1980 and 1981, neither camp experienced any problems with bears. Workers at the camps related incidents of black and brown bears encountering the fence and running away when shocked.

Several recommendations were made to minimize human-carnivore problems. These included 1) environmental briefings for workers before they enter the field, supplemented with additional briefings at the camps, 2) immediate dismissal of any worker caught feeding animals, 3) surrounding camps with electrified animal-proof fences, 4) dealing with nuisance animals immediately, through hazing, transplanting, or shooting, to minimize the probability of the animal becoming accustomed to obtaining a reward in areas of human activity, 5) adequate storage of food, and 6) proper collection, storage, incineration, and burial of garbage and other potential attractant wastes.

Activity: fencing; human disturbance; solid waste disposal; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Follmann, E.H., R.A. Dietrich, and J.L. Hechtel. 1980. Recommended carnivore control program for the Northwest Alaskan pipeline project including a review of human-carnivore encounter problems and animal deterrent methodology. Final Rept. Prepared for Northwest Alaskan Pipeline Company. Institute of Arctic Biology. Univ. Alaska. 113 pp. (UAF)*

This review paper examined the human-carnivore problems that occurred during construction of the trans-Alaska pipeline system during the 1970's and also on a broader scale, reviewed laws and regulations regarding those problems, reviewed methods to avoid and minimize human-carnivore encounter problems for the Northwest Alaskan pipeline project, and made recommendations to avoid and minimize adverse encounters between humans and carnivores along the pipeline corridor. References reviewed were primarily from the 1970's and geographically from the northern United States, Canada, and Alaska. Species reviewed included brown and black bears, wolves, coyotes, and red and arctic foxes. Habitat used by each species was not specifically addressed.

Brown bears. The activities of solid waste disposal, human disturbance, transport of oil by land, and transport of personnel/equipment/material by land and air produced documented direct impacts of attraction to an artificial food source, change in level of harvest, and active harassment. Bears were attracted to improperly stored and disposed garbage at trans-Alaska pipeline construction camps and work areas and to hand-outs from workers. Firecrackers, cracker-shells, vehicles, and helicopters were used to haze bears away from camps and work areas. Several problem bears were translocated to other areas, with the result, at least in one case, of merely transferring the problem to another location. Several bears were shot when less extreme measures failed to drive them away from camps and worksites. The results of dosing bears with an emetic proved inconclusive. Recommendations to minimize human-bear encounters included 1) prohibition of animal feeding, 2) proper food storage and garbage disposal, 3) a briefing for all workers informing them of environmental concerns, particularly regarding feeding and harassment of animals and solid waste disposal, and 4) installation of fences around construction camps and permanent facilities. Three fence designs, two involving electrified wires and each representing a different level of animal deterrent capability, are proposed. Detailed design specifications are proposed for each fence.

Activity: fencing; human disturbance; solid waste disposal; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Garner, G.W., G.J. Weiler, and L.D. Martin. 1983. Ecology of brown bears inhabiting the coastal plain and adjacent foothills and mountains of the northeastern portion of the Arctic National Wildlife Refuge. Pages 275-290 in G.W. Garner and P.E. Reynolds, eds. 1982 update report: baseline study of the fish, wildlife, and their habitats. Arctic National Wildlife Refuge Coastal Plan Resource Assessment. USDI:USFWS, Anchorage, AK. January 1983. (UAF)

This paper reports on field work conducted from June to November 1982 on brown bears of both sexes and all ages in the Arctic National Wildlife Refuge, northeastern Alaska. Objectives of this study were to determine the location of bear dens, to determine seasonal use of habitat, to determine population size, structure, status, and productivity, and to determine seasonal interrelationships between brown bears and other species (e.g., caribou). Relocation of radio-collared bears was used to carry out several of these objectives. Habitat within the study area includes coastal and shrub tundra, mountains, and riparian thickets. The activity of transporting personnel/equipment/material by air produced a documented direct impact of passive harassment. In 8 of 14 occasions, bears observed at open den sites in late fall moved and established new den sites. It is tentatively believed that disturbance by the survey aircraft caused the change of den sites.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Geist, V. 1978. Behavior. Pages 283-296 in J.L. Schmidt and D.L. Gilbert, eds. Big game of North America: ecology and management. Harrisburg, PA. Stackpole Books. (UAF)#

The principles of learning explain many responses of wildlife to human disturbance. Animals may initially react with fright to an unusual sound, but subsequent behavior depends on the experiences associated with the sound. Animals often learn to ignore persistent, localized noise (e.g., airports, industrial activity) that they can approach or avoid. They will respond with excitation and flight to sounds associated with alarming events (e.g., pursuit by vehicle) but may search for the source of sounds with positive associations (e.g., chainsaw noise indicating food to deer).

Avoidance or abandonment of areas associated with unpleasant experiences, such as human disturbance, may result in a reduction in range. Predation, increased energy expenditure, and loss of access to resources may subsequently reduce the population. Highly gregarious ungulates are generally most seriously affected.

If human contacts continue to occur and are not negatively reinforced, grizzly bears will not only learn to ignore people but will proceed to the next stage of behavior--total exploration--which must be preceded by attack.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Griffel, D. 1982. Predator-livestock relationships in summer on the Targhee National Forest, Idaho. Pages 295-306 in J.M. Peak and P.D. Dalke, eds. Wildlife-Livestock Relationships Symposium: Proceedings 10. University of Idaho, Forest, Wildlife and Range Experiment Station, Moscow, ID. 614 pp. (UAF)#

Predation by black bear (Ursus americanus) and grizzly bear (Ursus arctos) on domestic sheep (Ovis aries), and its relation to other causes of livestock loss is described. Four sheep allotments on the Targhee National Forest having a history of grizzly bear occurrence were monitored from 1976-1978 on a regular basis to verify sheep losses and causes of death. Of 19,225 sheep grazed during this period, 614 were lost, 370 were verified as having been killed by predators, 45 died of disease, and 199 were never located.

Livestock owners and predator control agents, utilizing three different methods of control, killed 32 black bears. A minimum of 12 individual grizzlies, including cubs, frequented the study area. Eight of the 12 are believed to have been responsible for sheep mortality. Estimates of up to 7 grizzly bear deaths may have been associated with these allotments.

Activity: grazing.

Impact: attraction to artificial food source; harvest, change in level.

Hanley, P.T., J.E. Hemming, J.W. Morsell, T.A. Morehouse, L.E. Leask, and G.S. Harrison. 1980. Natural resource protection and petroleum development in Alaska. USDI:USFWS. 318 pp. (ARL)#

General impacts of petroleum development in Alaska are described. Noise may cause animals to avoid areas while activity is in progress. Land surface alteration has eliminated critical habitat, particularly nest sites of shorebirds, which have been displaced in large numbers with adverse effects on their reproductive potential. Shorebird nesting densities have been reduced as a result of the "road effect"--a combination of noise, activity, and dust ("dust shadow") which extends the area of disturbance and habitat alteration beyond the actual road. Use of cleared areas (roads, rights-of-way, etc.) may increase for some species due to the presence of preferred food, increased edge, and easier travel routes. Improper handling of garbage and active feeding by workers have attracted bears and other scavengers which have subsequently shown signs of behavior alteration, including loss of fear of humans. Fuel, oil, and mud spills reduce habitat by destroying vegetation. Fuel spills are especially destructive. Water pollution is more serious than land pollution and may cause injury or death of wildlife.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Hanley, P.T., J.E. Hemming, J.W. Morsell, T.A. Morehouse, L.E. Leask, and G.S. Harrison. 1981. Natural resource protection and petroleum development in Alaska. USFWS, Office of Biol. Services, Washington, D.C. August. 306 pp. (ADF&G-A)*

In this review and discussion article, the effects of petroleum development on moose, black and brown bear, arctic and red fox, and wolf of all life stages on Alaska's North Slope, along the trans-Alaska pipeline, in the Cook Inlet area, and on the Kenai Peninsula are considered. The field studies upon which the article is based were performed at all seasons of the year at various times between 1944 and 1981. Habitat types range from arctic tundra on the North Slope to boreal forest on the Kenai Peninsula, including most habitat types in Alaska along the trans-Alaska pipeline. Effects on caribou, fish, and waterfowl of all life stages are also discussed. Documented impacts to fish and wildlife are few, as the article concentrates on physical alterations in the environment that may cause impacts to fish or wildlife. Mitigation guidelines are given but are not based on documented impacts.

Moose. The activity of transporting oil by land was responsible for the documented direct impact of barrier to movement. Conclusive results showed that moose passed under pipe at heights of 1.8-2.4 m (6-8 ft) more frequently than at other heights. The activity of transporting personnel/equipment/- material by air was responsible for the potential direct impact of passive harassment. Conclusive results showed that overflights at altitudes of 305 m (1000 ft) or less during low cloud conditions, did not result in harassment of moose along the Colville River.

Bear. The activities of drilling and or transporting oil by land were responsible for the documented direct impact of attraction to an artificial food source. Conclusive results showed that brown bears were attracted to garbage in drilling camps in the NPR-A and that brown and black bears were attracted to construction camps and construction areas for the trans-Alaska pipeline. The activity of blasting was responsible for the documented direct impact of passive harassment. Brown bears within 2 km (1.25 mi) of winter seismic blasting in NPR-A conclusively moved within their dens as a result of the blasts.

Arctic fox and wolf. The activities of drilling and of transporting oil by land were responsible for the direct documented impact of attraction to an artificial food source. Arctic foxes were attracted to construction camps for the trans-Alaska pipeline, and higher populations thrive in the Prudhoe Bay area than prior to development, because of feeding by humans and on garbage. Both wolves and foxes were attracted to NPR-A drilling camps.

Activity: blasting; drilling; transport of oil/gas/water - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Harding, L., and J.A. Nagy. 1980. Responses of grizzly bears to hydrocarbon exploration on Richards Island, Northwest Territories, Canada. Pages 277-280 in C.J. Martinka and K.L. McArthur, eds. Bears - their biology and management. Fourth international conference on bear research and management, Kalispell, MT, February 1977. Bear Biology Assoc. Conf. Ser. No. 3. (UAF)

In this field research paper and brief review of other studies at the same site, responses of brown bears of all life stages to hydrocarbon exploration on Richards Island in the Mackenzie Delta, Northwest Territories, Canada, were studied opportunistically from May through September 1972-1975. Specific surveys of dens were made, and individual bears were tracked. The habitat type of arctic coastal tundra is essentially identical to that of northern Alaska, and the geographic area is just east of Alaska. The activities of drilling, grading/plowing, human disturbance, sewage disposal, and transporting personnel/equipment/material by land and air were responsible for the documented direct impacts of active and passive harassment and the indirect impact of terrain alteration or destruction. A potential direct impact included attraction to an artificial food source. Bears wintered successfully within 1.6-6.4 km (1-4 mi) of active camps, but a seismic vehicle driven over one den caused abandonment, and another active den was destroyed after the bear fled during gravel mining. Travelling bears avoided camps by distances of 1-2 km (0.6-1.25 mi), and foraging bears or those leaving dens by 3-7.2 km (2-4.5 mi). Proper garbage disposal usually did not attract bears, and only six times in the four year study did any of the 13-23 bears on the island enter camps. One bear that remained at a sewage lagoon was relocated. Responses of habituated bears to helicopters were aversive in 88% of cases. For aversive responses to fixed-wing single-engine airplanes, the percentage was 61 (no distances given). Although current levels of development cannot be proven to affect the brown bear population, development of production facilities is expected to reduce the population to where its continued existence will depend on immigration.

Activity: drilling; grading/plowing; human disturbance; sewage disposal; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); terrain alteration or destruction (e.g., raptor cliffs).

Herrero, S. 1970. Human injury inflicted by grizzly bears. Science 170: 593-598. (UAF)

In this review paper, the author examined the reported cases of grizzly bear attacks on humans in the national parks of North America and the associated human activities preceding the attacks. Recorded attacks were summarized for the period 1900-1969. Habitat data for bear-human encounters were not provided. The activities of human disturbance and solid waste disposal produced documented direct impacts of active harassment and attraction to an artificial food source. Five attacks (of a total of 77) were the result of photographing a sow with cubs at close range or chasing grizzly bear cubs. Bears were attracted to garbage dumps and occasionally campgrounds in search of food. Incidents involving persons camping were tentatively related to grizzlies that have fed on human garbage or food, especially in the presence of humans.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Herrero, S. 1976. Conflicts between man and grizzly bears in the national parks of North America. Pages 121-145 in M.R. Pelton, J.W. Lentfer, and G.E. Folk, eds. Bears - their biology and management. IUCN Publ. New Ser. No. 40. Morges, Switzerland. (UAF)

This review paper examines brown bear-man conflicts, primarily bear attacks, in national parks of Canada and the United States (including Mt. McKinley Park) for the years 1872 to 1973. The activities of human disturbance and solid waste disposal produced documented direct impacts of active harassment and attraction to an artificial food source. Improper storage of food and/or garbage, from which brown bears indirectly lost some of their avoidance behavior towards people and sometimes became directly aggressive towards people, was held responsible for a majority of the bear attacks on humans. Two instances were recorded where attacks were preceeded by harassment of the attacking bear. Recommendations for avoiding attacks by brown bears and procedures to follow if attacked are presented.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Herrero, S. 1982. Bears and the proposed Canadian Pacific Railway construction camps in Glacier National Park, British Columbia. BIOS Environmental Research and Planning Associates, Ltd., Calgary, Alberta. (ADF&G-F)*

The objective of this paper was to review and define the problems that might develop regarding brown and black bears and people should Canadian Pacific Railway construction camps be built within Glacier National Park, British Columbia. Papers reviewed were primarily from studies conducted in the 1970's and 1980's on brown and black bears in Alaska, Canada, and the northern United States. Substantial additional information was obtained via personal communications with bear biologists. Referenced studies examined bears of all age and sex categories. Habitat within Glacier National Park includes closed coniferous forest, open subalpine forest, avalanche slopes, and alpine tundra, similar in structure to bear habitat found in portions of Alaska. The activities of solid waste disposal and human disturbance produced documented direct impacts of attraction to an artificial food source, change in level of harvest, and active harassment. Attraction to garbage and food storage areas by both black and brown bears was documented for several situations, including construction of the trans-Alaska oil pipeline system. Bears were also deliberately fed, in particular by workers constructing the trans-Alaska oil pipeline. An increased harvest of bears was also documented and included both shooting of "problem bears" and harvest by project workers. Several recommendations were proposed to prevent bear-human problems at construction camps. These included 1) establishing camps 300 m (1,000 ft) from bear cover, 2) maintaining bright lighting in camps during periods of darkness to potentially discourage approach by bears, 3) strict regulations against feeding of bears, 4) environmental awareness programs for workers, and 5) separation of food and garbage storage areas from the rest of the camp and bears by fences. Several fence designs were described, including those of Follmann et al. 1980. An electrified camp perimeter fence, with gate attendants, was recommended, in conjunction with separate fencing around food and garbage storage areas. Indoor storage of food was also recommended.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Herrero, S. 1985. Bear attacks: their causes and avoidance. Piscataway, New Jersey: Winchester Press. 287 pp. (ADF&G-F, Game)*

This book primarily reviews incidents of brown and black bear encounters with humans, the factors leading to encounters, and ways of preventing or reducing their occurrence. Substantial information is also provided on the characteristics, evolution, feeding, habitat use, and behavior of both brown and black bears. Information presented involved bears primarily within the United States, Alaska, and Canada. Publications dealing with bears that were cited in this book were primarily from the 1970's and 1980's, although information dating to the late 1800's was also presented. The activities of human disturbance and solid waste disposal produced documented direct impacts of attraction to an artificial food source, harassment, and an increased level of harvest. Some of the bear-human encounters discussed were the result of harassment of bears by humans. Discussions of bears attracted to campgrounds and garbage were prominent. Bears were often killed following encounters with humans. Extensive treatment was given to means of avoiding or lessening personal injury from bear attacks and included the maintenance of garbage-free camps, avoidance of heavily used bear habitat, and the avoidance of surprising bears, particularly females with cubs. Recommendations to reduce impacts to bears included that 1) garbage be incinerated and the incinerator and waste storage areas be surrounded by an electric fence, 2) food and food waste be stored in bear-resistant odor-trapping containers or, preferably, within a fenced area, 3) trails preferably be located to avoid important bear habitat, and if it is necessary to route trails through important bear habitat, the trails be designed to allow people to see at least 50 m (165 ft) ahead, and 4) campgrounds be located away from seasonally important bear habitat.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Hoak, J.H., T.W. Clark, and J.L. Weaver. 1983. Of grizzly bears and commercial outfitters in Bridger-Teton National Forest, Wyoming. Pages 110-117 in E.C. Meslow, ed. Bears - their biology and management. Fifth International conference on bear research and management. Madison, WI. February 1980. (ADF&G-F)*

The purposes of this field and review study were to document the distribution and abundance of grizzly bears, to map and describe outfitting camp layouts, compile case histories of bear-human encounters at camps, and to make management recommendations. Information on all sex and age classes of bears was gathered by direct observation of bears and bear sign and by outfitter interviews, May through November, 1977 and 1978, within the Bridger-Teton National Forest, northwestern Wyoming. Additional information on grizzly bear reports in this area was used for the years 1968 to 1976. Habitat within the area is a combination of open and closed subalpine coniferous forest, riparian communities, and alpine meadows, similar in structure to habitat used by brown bears in Alaska. The activities of solid waste disposal, grazing, and human disturbance produced documented direct impacts of attraction to an artificial food source, active harassment, and increase in level of harvest. Conclusive results showed that bears were attracted to outfitter camps because of improperly stored food, hunter-killed big game carcasses, and garbage. Bears were also attracted to horse feed at these camps. Bears were usually chased out of camps, but on several occasions bears were killed. Recommendations to minimize bear-human encounters at outfitter camps included 1) keeping all food and garbage unavailable to bears at all times, 2) not burying food materials or emptied containers, 3) not leaving food or food containers in caches between seasons, 4) securing livestock feed in bear-proof containers or out of reach of bears, 5) packing out game carcasses immediately or hanging them at least 4.6 m (15 ft) above the ground surface, with a 3.1 m (10 ft) minimum clearance between suspension ropes and the highest access point, and a minimum of 2 m (6.5 ft) between meat and the nearest vertical structure of tree. Where storage of food is not possible out of reach of bears or in bear-proof containers, mothballs or napthalene crystals were suggested as possible repellents, based on statements from some outfitters. It was also recommended that camp placement be in areas as far from bear cover as possible and that the distance between human quarters and food sources be maximized.

Activity: grazing; human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Jonkel, C. 1980. Grizzly bears and livestock. Western Wildlands 6(4): 11-14. (UAF)*

In this semipopular review article, interactions between brown bears of all life stages that occur outside of the den and domestic sheep and cattle, primarily in Montana are discussed. Papers cited are dated from 1959 through 1980, with most studies having been done in the 1970's. Exact dates and locations of the studies are not included. Although the study areas are mainly south of Alaska, the high elevations result in habitat types similar to those used by brown bears in Alaska: coniferous and aspen forests, subalpine meadows, riparian zones, and alpine tundra. The activity of grazing was responsible for documented direct impacts of attraction to artificial food source, competition with introduced species, active and passive harassment, and change in harvest level, and indirect impacts of vegetation composition change to less preferred or useable species and vegetation damage or destruction due to grazing by domestic animals. The activity of solid waste disposal was responsible for the direct impact of attraction to an artificial food source. Most conflicts between brown bears, sheep, and cattle occur on spring range before bears can move to higher elevations. Conflicts also occur when sheep are trailed into grizzly summer range both during years in which weather variation results in low bear food production and for a year after such events and during dispersal of subadult males in May and June. Conflicts with cattle are primarily for space and for riparian forbs, grasses, and sedges low in cellulose, whereas conflicts with sheep involve forage destruction and predation. Management recommendations include the following: 1) avoid bringing livestock onto spring brown bear range before bears can move to higher elevations (early July); 2) avoid overgrazing or trampling important spring bear habitat in riparian zones and aspen groves; 3) keep sheep out of key brown bear range by regional land planning and regulation on government lands and by land trades or replacement of sheep by cattle on private lands; 4) kill and dispose of sheep dying on the trail by burial or treatment with strong chemicals; 5) remove and burn or bury livestock carcasses at some distance from corrals; 6) avoid bedding livestock in cover which acts as essential travel corridors for dispersing immature bears; 7) thoroughly investigate alleged cases of brown bear predation on livestock; 8) use limited hunting of brown bears to eliminate those with undesirable behavior; 9) improve communication between government agencies and the public; and 10) consider limited compensation for legitimate excessive livestock losses to bears.

Activity: grazing; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals.

Jope, K.L. 1983. Implications of habituation for hikers in grizzly bear habitat. Paper presented at the sixth international conference on bear research and management. Bear Bio. Assoc. Grand Canyon, AZ. (ADF&G-A, Game) #

Behavior of grizzly bears (Ursus arctos) toward people was studied by examining hiker's reports of grizzly bear observations during 1980-1981 in an area of Glacier National Park, Montana, that was heavily used by day-hikers. Of concern were the apparent loss of fear of people by grizzly bears in the study area and the increasing rate of human injuries by grizzly bears in the park. Most hiker injuries have been inflicted after the hiker was charged by the bear. In the study area, only hikers that did not have bear-bells were charged. Although bears were occasionally startled by hikers on trails with the high levels of human use and were seen as frequently as on the trails with relatively little human use, charges occurred primarily on trails with little human use. This finding, as well as the tendency for hiker injuries to occur in areas of the park that received relatively little human use, indicated that habituation of grizzly bears to high numbers of hikers in the habitat may reduce the rate of injuries resulting from fear-induced aggression.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Jorgensen, C.J. 1983. Bear-sheep interactions, Targhee National Forest. Pages 191-200 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management. Madison, WI, February 1980. (ADF&G-F)*

In this field research report, black bears of a variety of sexes and ages and two mature male brown bears were captured, tagged, and radio-collared in 1976 and 1977 in northwestern Wyoming, a few kilometers south of Yellowstone National Park, and their movements studied in relation to domestic sheep grazing. The study area, although at a more southerly latitude than Alaska, is at moderately high elevations and includes habitat types similar to those occurring in Alaska: closed and open coniferous and aspen forests with berry-producing shrub and grass understories and glacial marshes and riparian zones. At lower elevations, lodgepole pine forests and dry meadows are not comparable to Alaskan habitats but are used by bears only late in the fall. The activity of grazing was responsible for documented direct impacts of attraction to artificial food source, change in harvest level, and documented indirect impacts of competition with introduced domestic species, vegetation composition change to less preferred species, and vegetation damage or destruction due to grazing. Movements of bears were associated with the availability of vegetative food sources, grass, and succulent forbs in spring and early summer, and berries from July through November, and were either not correlated or negatively correlated with domestic sheep movements. Black bears left their home ranges when sheep were moved onto them in two cases, returning after sheep were removed. Sheep were grazed on limited areas of succulent vegetation also eaten by black and brown bears, causing competition, trampling, and overgrazing. Three black bears moved toward sheep herds in their home ranges, and one killed sheep during the day and at night. One of the brown bears killed sheep, only at night, but only when they were encountered on his customary feeding route. The brown bear killed and disturbed more sheep than did the black bear. Mitigation recommendations are to 1) avoid grazing domestic sheep in areas heavily used by bears (succulent vegetation in early summer and berry patches in late summer), or increase herder surveillance; 2) avoid excessive grazing, trailing and trampling by sheep in areas of succulent vegetation (also used by bears); 3) deter bear depredation by using aversion methods, portable corrals, sheep-protecting dogs, and by properly disposing of carcasses; 4) avoid shooting at bears without positive identification; and 5) avoid setting snares for suspected killer bears after sheep have been moved to a new bedground, as innocent scavenging bears are likely to be caught.

Activity: grazing.

Impact: attraction to artificial food source; harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals.

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

In this review article, the interactions between agriculture and wildlife, including bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the continguous 48 states are discussed. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level, and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine during white settlement, are attributed to overharvest and in some cases habitat destruction. In the contiguous 40 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain growing areas in Alaska, in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms, and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grazing.

Impact: attraction to artificial food source.

Klein, D.R. 1973. The reaction of some northern mammals to aircraft disturbance. Pages 377-383 in 11th international congress of game biologists, Stockholm, Sweden. (UAF)

In this field research paper, reactions to low altitude aircraft of caribou, moose, brown bear and wolf of all life stages occurring in summer were made during May through July, 1973, in northeastern Alaska. The habitat type was arctic tundra. The activity of transporting personnel, equipment, or material by air was responsible for the documented direct impacts of active and passive harassment. Although this is a preliminary report of a study in progress and most of the observations were made on caribou (see separate annotation), tentative results are reported for the other species. Moose were usually indifferent to the single-engine, fixed-wing aircraft and helicopter, and those that ran were generally cows with young calves. Brown bears reacted very strongly, running at a distance for cover or sharply away from the flight path. Wolves were disturbed very little, contrary to the extreme alarm the populations had shown until four years previous when aerial hunting was banned. Distances are not stated. Animal populations had been habituated to 15-20 overflights annually, prior to the study.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Knight, R.R., and S.L. Judd. 1983. Grizzly bears that kill livestock. Pages 186-190 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management. Madison, WI, February 1980. (ADF&G-F)*

In this field research article, brown bears of all life stages except cubs in the den were fitted with radio transmitters within and around Yellowstone National Park, Wyoming, between 1974 and 1979, and foraging patterns and depredation of domestic sheep and cattle were documented. Although the latitude of the study area is south of Alaska, the high elevation and mountainous terrain are compensatory, resulting in habitat types similar to those utilized by brown bears in Alaska: closed coniferous forests, open subalpine coniferous forests, riparian zones, and alpine tundra. The activities of grazing and human disturbance were responsible for the documented direct impacts of attraction to artificial food source, change in harvest level, and active harassment. Conclusive results showed that bears that killed livestock and those that did not had similar foraging patterns both within and outside the park and that livestock killers utilized other food sources as well. Only adult brown bears killed cattle, and bears encountered cattle without killing them. Cattle carrion was eaten. Sheep, however, were killed in nearly every case in which bears of all ages encountered them, in spite of the fact that herders accompanied the sheep while cattle were free-ranging. Although losses of sheep to brown bears were less than half the losses due to herding practices, loss of bears to sheep herders is a significant mortality factor for the Yellowstone population. Mitigation guidelines are to 1) greatly reduce, and preferably eliminate, domestic sheep grazing within 20 km (12 mi) of Yellowstone National Park; 2) allow cattle grazing in brown bear habitat only with the understanding that cattle owners absorb brown bear predation losses; and 3) attempt to relocate problem bears that kill cattle.

Activity: grazing; human disturbance.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Lentfer, J.W., S.H. Eide, L.H. Miller, and G.N. Bos. 1968. Report on 1967 brown bear studies. Alaska Fed. Aid in Wildl. Res. Rept. Projs. W-15-R-2 and 3. 31 pp. (GDL)#

Report on Kodiak bear-cattle relationships on Kodiak Island. Ten of 22 dead cattle were killed by bears. Of 13 bears killed as potential predators on the cattle leases, three were sport kills, one was by a rancher, and nine were by department personnel.

Activity: grazing.

Impact: attraction to artificial food source; harvest, change in level.

Lentfer, J.W., L.H. Miller, and G.N. Bos. 1969. Report on 1968 brown bear studies. Fed. Aid in Wildl. Rest. Projs. W-15-R-3 and W-17-1. 41 pp. (GDL) #

Report on Kodiak bear-cattle-relationships on Kodiak Island. The report presents figures for bear-killed cattle and the number of bears killed as potential predators.

Activity: grazing.

Impact: attraction to artificial food source; harvest, change in level.

Linderman, S. 1974. Ground tracking of arctic grizzly bears. Fed. Aid in Wildl. Rest. Proj. W-17-6, Job 4.12R. Final Rept. 24 pp. (GDL)#

A mature male grizzly bear was immobilized May 10, 1973, fitted with a radio transmitter collar, and followed from the ground and from aircraft until June 18. Visual contact with the bear was maintained whenever possible, at distances of 0.8-1.6 km (0.5-1.0 mi). The radio collar seemed to be a minor but constant irritation. Aircraft did not usually produce a strong response by the bear unless they passed within about 150 m (500 ft). Observations of feeding indicated the bear ate mostly grasses, sedges, and overwintered berries. The bear also ate the remains of caribou killed by wolves. Analysis of activity patterns showed that feeding was the predominant activity for morning-midday, and resting and traveling predominated for evening-night. During the period of observation, the marked bear ranged over a 43 km (27 mi) length of the Canning River and a 6.4 km (4 mi) section of a major tributary. Breeding behavior was observed and described. Ground tracking, with the aid of a radio transmitter, is considered technically feasible, but demanding.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Mace, R.D., and C.J. Jonkel. 1980. The effects of logging activity on grizzly bear movements. Paper presented at the fifth international conference on bear research and management. Bear Bio. Assoc. Madison, WI. (ADF&G-A, Game)#

Information has been obtained on the daily and annual movement response of instrumented grizzly bears to logging activity in the South Fork of the Flathead River, Montana. Interim data suggest that logging activities do affect both daily and annual movement patterns. Timber harvesting was conducted in two drainages within the annual home ranges of three instrumented grizzly bears. None of the grizzlies were known to enter the immediate drainages where logging was being conducted but did use the surrounding ridges. Both drainages were known to contain grizzlies prior to the initiation of logging in the early 1960's and since then during periods when logging crews were not on-site (e.g., early spring, late fall, and winter). This information should prove useful to state and federal land management agencies when formulating sale area plans with the intent of lessening disturbance to resident grizzlies.

Activity: clearing and tree harvest

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Marsh, J.S. 1972. Bears and man in Glacier National Park, British Columbia, 1880-1980. Pages 289-296 in S. Herrero, ed. Bears - their biology and management. IUCN Publ. New Ser. No. 23. Morges, Switzerland. (UAF)*

In this historical review article, interactions of brown bears of all life stages and man in Glacier National Park, British Columbia, between 1880 and 1980 are discussed. The high elevation and mountainous terrain of the area result in a climate and habitat types of coniferous and aspen forests, riparian zones, and alpine tundra similar to Alaskan conditions. The activities of human disturbance, solid waste disposal, and transportation of personnel/equipment/material by land were responsible for the documented direct impacts of attraction to artificial food source, collisions with trains, change in harvest level, and passive harassment. Completion of a railroad through the area increased harvest prior to the prohibition of hunting and caused an unknown number of collision deaths. Attraction of bears to food at camps and to garbage led to shooting of nuisance bears. Mitigative guidelines include the following: 1) improve garbage collection and disposal so that bears cannot get to it at any time, including after incineration; 2) locate and design campgrounds to minimize the chance of bears feeding in them; 3) remove nuisance bears immediately and effectively for the long term (e.g., by helicopter to roadless areas of the park); 4) zone and manage a portion of the park as a grizzly refuge; 5) zealously enforce and publicize laws prohibiting feeding or intimidating bears; and 6) educate the public about bears before they visit the park.

[Reviewer's note: Guideline no. 3 is in apparent conflict with Craighead and Craighead (1972), who state that bears not habituated to man and not dangerous occasionally visit campgrounds and recommend not killing bears until the fourth recapture.]

Activity: human disturbance; solid waste disposal; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Martin, P. 1983. Factors influencing globe huckleberry fruit production in northwestern Montana. Pages 159-165 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management. Madison, WI. February, 1980. (ADF&G-F)*

In this field research paper, habitat used by brown bears of all life stages except those in the den was studied in northwestern Montana and northern Idaho during the summers of 1977 and 1978. Although the geographic area is south of Alaska, the high elevation allows development of habitat types analogous to those used by brown bears in Alaska. Globe huckleberries do not occur in Alaska, but other berry species are equally important to brown bears in Alaska, grow in similar coniferous forest vegetation types, and are likely to exhibit similar responses to soil and vegetation disturbance. The activities of burning, clearing and tree harvest, and grading and plowing were responsible for documented indirect impacts of vegetation composition change to less preferred or useable species, vegetation damage or destruction due to fire, and vegetation damage or destruction due to mechanical removal or material overlay. Berry stands on mesic aspects that had been burned by wildfire 25-60 years earlier or clear-cut and broadcast burned 8-15 years earlier were the most productive, compared to stands on mesic aspects burned 60-100 years earlier, left undisturbed, or clear-cut and scarified, and all stands on xeric aspects. Development of a tree canopy of 30% coverage or more inhibited fruiting of the huckleberry. Hot fires kill huckleberry rhizomes, as does soil scarification, severely inhibiting berry production. Based on this study and citation of a 1983 paper by Zager that indicated that brown bears make limited use of clear-cuts although they prefer wildfire-burned areas, the author recommends that wildfires be allowed to burn in brown bear habitat, particularly at higher elevations.

Activity: burning; clearing and tree harvest; grading/plowing.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Martinka, C.J. 1976. Ecological role and management of grizzly bears in Glacier National Park, Montana. Pages 147-156 in M.R. Pelton, J.W. Lentfer, and G.E. Folk, eds. Bears - their biology and management. IUCN Publ. New Ser. No. 40. Morges, Switzerland. (UAF)*

In this general discussion paper, management practices for brown bears of all life stages in Glacier National Park, Montana, between 1967 and 1973 are described. Although the geographic area is south of Alaska, the high elevations and mountainous terrain justify extrapolation. Habitat types include montaine coniferous forest with grassland openings and riparian zones, and alpine tundra, functionally similar to habitats used by grizzlies in Alaska. The activity of human disturbance was responsible for the documented direct impact of passive harassment and indirect impact of vegetation composition change to less useable species. Temporary restrictions on back-country travel have mitigated the potential for human injuries and subsequent bear disposal or transplanting. The policy of wildfire suppression has resulted in a successional advance toward mature forests, creating conditions more favorable for black bears.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation composition, change to less preferred or useable species.

McArthur-Jope, K.L. 1983. Habituation of grizzly bears to people: a hypothesis. Pages 322-327 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management. Madison, WI. February 1980. (UAF)

In this field research paper, interactions between brown bears of all life stages and humans occurring from May through October were documented in high and low intensity human disturbance areas of Glacier National Park, Montana, between 1977 and 1979. Although the geographic area is south of Alaska, the high elevation and mountainous terrain compensate for the latitude, and the habitat types of closed and open subalpine fir forests with snowslide openings and alpine tundra are similar to those utilized by brown bears in Alaska. The activity of human disturbance was responsible for documented direct impacts of active and passive harassment. Conclusive results showed that in the area of the park subject to greater human disturbance by visitors, a lower percentage of brown bear sows with cubs or yearlings was present than in the rest of the park. Bears of all ages and sexes in the area of greater human disturbance were more habituated to humans, showing less avoidance and more neutral or approach behavior. Habituation increased during the early summers. Off-trail hiking, especially in open country, increased exposure of bears to humans and thus increased habituation. After habituation, brown bears are more likely to approach humans and, if a human enters within their individual distance, are more likely to assert dominance by charging and striking the human than to make a threatening bluff.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McCourt, K.H., J.D. Feist, D. Doll, and J.J. Russell. 1974. Disturbance studies of caribou and other mammals in the Yukon and Alaska, 1972. Arctic Gas Biol. Rept. Ser., Vol. 5. (UAF)*

Reactions of barren ground grizzly bears, caribou, and moose to disturbance from aircraft were recorded during the period March to October 1972 in conjunction with caribou field studies conducted at the same time in northeastern Alaska and the northern Yukon. Habitat types within the study area included northern boreal forest and coastal, shrub and alpine tundra. The activity of transporting personnel/equipment/material by air produced a documented direct impact of passive harassment. Results, based on a small sample size, indicated that the reactivity of brown bears to aircraft was highly variable and that a consistent trend of decreased sensitivity to aircraft with increased altitude did not exist. Brown bears were deemed more sensitive to aircraft disturbance than caribou or moose. Recommendations were 1) that aircraft maintain a flight level at a minimum of 334 m (1,000 ft) above ground level, 2) that rapid linear flight paths over animals be used, 3) that under no circumstances should unnecessary hovering or circling over bears be carried out with helicopters, and 4) that low-level flights over areas with known brown bear concentrations be avoided.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McCullough, D.R. 1982. Behavior, bears, and humans. Wildl. Soc. Bull. 10(1):27-33. (UAF)*

In this review and discussion article, the behavior of black and brown bears of all life stages except cubs in the den toward humans in national parks and other situations in which hunting does not occur is examined in relation to learning theory and management practices. Examples are drawn from a variety of studies conducted during different time periods in several geographic areas and habitat types, primarily in North America. The activities of human disturbance and solid waste disposal are responsible for documented direct impacts of attraction to artificial food source, active and passive harassment, and change in harvest level (removal of problem bears). Conclusive results of referenced studies are that bears remain a problem in areas where access to human food has been limited, and that problems have developed in areas where human food has been largely unavailable. The presence of humans in bear habitat, in the absence of negative conditioning such as hunting, will habituate bears to humans, increasing the risk of accidental encounters. Even occasional food rewards condition bears to seek food in response to human-related stimuli (e.g., scent, structures, equipment). The solution is to apply negative conditioning to bears, to make them wary of humans again, and also to educate humans about bears. Management recommendations include 1) negatively conditioning bears to humans by nonlethal means (e.g., rubber bullets, noxious or debilitating gasses, running with dogs) in parks and by hunting outside of parks, 2) teaching humans that bears are unpredictable and dangerous, and 3) removing bears already habituated and positively conditioned to humans, as the extreme degree of negative conditioning required to overcome long-term previous learning would be difficult to accomplish.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Mealey, S.P., C.J. Jonkel, and R. Demarchi. 1977. Habitat criteria for grizzly bear management. Proc. Int. Congr. Game Biol. 13:276-289. ADF&G-F) *

This field study was conducted during 1975 and 1976 in an attempt to evaluate and rate grizzly bear habitat on the basis of occurrence, range, and coverage of grizzly food plants. The study area included grizzly range in parts of northwestern Montana, northern Idaho, northeastern Washington, southeastern British Columbia, and southwestern Alberta. Habitat within the study area was mountainous terrain, covered with varying percentages of meadows, shrubs, and logged and unlogged forest. This habitat is physiographically similar to some grizzly habitat in Alaska. The activity of grazing produced a documented direct impact of competition with introduced domestic species. Domestic cattle used 80 to 100% of all important grizzly foods on three avalanche chutes that were studied within grizzly habitat. The activity of clearing and tree harvest produced a documented direct impact of vegetation damage/destruction due to mechanical removal. Clear-cuts with postlogging treatment (mechanical scarification and dozer piling or burning of slash) lacked well-established stands of perennial shrubs and herbs important as grizzly food and cover that were present on logged sites without postlogging treatment. Clear-cuts with extensive postlogging treatment of the entire area showed no evidence of use by grizzlies. Desirable treatments recommended for clear-cuts in grizzly habitat include the following: 1) leave or cover patches in larger cuts; 2) minimize soil scarification (20% or less, preferably in a strip configuration); and 3) dispose of slash by burning or possibly omit slash disposal.

Activity: clearing and tree harvest; grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Merrill, E.H. 1978. Bear depredations at backcountry campgrounds in Glacier National Park. Wildl. Soc. Bull. 6(3):123-127. (UAF)*

In this report of field research performed in the summer of 1975 and correlated with records of bear incidents from 1967 to 1974 in Glacier National Park, Montana, black and brown bears of all life stages are discussed. The high elevation and mountainous terrain of the study area compensates for its latitude, resulting in habitat types comparable to those utilized by brown and black bears in Alaska: mature coniferous forest, open subalpine coniferous forest, alpine tundra and meadows, and snowslide areas. The activities of human disturbance and solid waste disposal were responsible for documented direct impacts of active and passive harassment, and attraction to an artificial food source. Conclusive results showed no significant differences between brown and black bear incidents in their correlation with campground characteristics. An unexpectedly high number of bear incidents occurred in deteriorated (heavy use, along major trails also used by bears) campgrounds in mature forests that were within 5 km (3 mi) of a developed area and had large party limits (concentrating and increasing the garbage problem) and that had good fishing nearby (improper entrail disposal). Proposed mitigative guidelines are 1) to locate campgrounds well away from lake shores and major trail systems to avoid directing bears through campgrounds and to discourage disposal of fish entrails in the campground, 2) to require use of self contained stoves to minimize accumulation of partially burned refuse, 3) to reduce the concentrated use of campgrounds by lowering party size limits, alternating seasonal use of campgrounds, regulating use in areas without designated campgrounds, and closing drainages heavily used by sows with cubs, 4) to isolate campgrounds from developed park facilities where garbage accumulates, and 5) to impose and enforce penalties for improper disposal of garbage in campgrounds.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Milke, G. 1977. Animal feeding: problems and solutions. Joint State/Fed. Fish and Wildl. Advisory Team Spec. Rept. No. 14. 11 pp. (UAF)*

This paper reviews the problem of animal feeding that occurred during construction of the Trans-Alaska Pipeline System during the period 1974 through 1977. Grizzly bears, black bears, wolves, red and arctic foxes, gulls, ravens, and ground squirrels are discussed. Habitat within the area of concern included arctic, shrub, and alpine tundra, open and closed coniferous forest, and riparian habitat. The activities of transporting of oil/gas/water by land, transporting of personnel/equipment/material by air and land, grading and plowing, solid waste disposal, and human disturbance produced documented direct impacts of active and passive harassment, attraction to an artificial food source, collision with vehicles, and change in level of harvest. Bears, wolves, and foxes were attracted to improperly stored food and garbage at construction camps and pump stations and to handouts from workers at camps and worksites. Bears and wolves were harassed by helicopters, vehicles, and guns in attempts to drive them away from camps and worksites. Problem animals, particularly bears, were occasionally killed. Additional animals were also killed by some workers in more remote areas. Emetics were given, with mixed results, to some animals to stimulate an avoidance response. Recommendations included 1) education of workers to discourage feeding of animals, 2) incineration of edible garbage, 3) immediate removal of litter and garbage from worksites, 4) storage of food or garbage in buildings or animal-proof containers, and 5) fencing of all construction camps and dumps.

Activity: grading/plowing; human disturbance; solid waste disposal; transport of oil/gas/water - land; transport of personnel/equipment/-material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Miller, G.D. 1983. Responses of captive grizzly and polar bears to potential repellents. Pages 275-279 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management, Madison, WI. February 1980. (ADF&G-F)

In this laboratory research paper, responses of two mature male brown bears captured as problem bears in Glacier National Park, Canada, and an immature and a mature female polar bear captured near Churchill, Manitoba, Canada, in 1977 and 1978, to potential repellents while being held in an experimental chamber were measured. Geographic area and habitat type are not applicable to this study. The activity of human disturbance was responsible for the documented direct impact of active harassment. Extremely loud, sharp sounds and a loom (sudden display of a 1 m by 1.5 m [3.25 ft by 4.9 ft] plywood sheet) effectively stopped charges of both bear species and deterred examination of the stimulus (person) for five minutes or less. Irritating chemical sprays to the eyes were tested only on brown bears. Most were effective, and Halt, a repellent for attacking dogs, was dramatically so. Field tests are recommended.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Mundy, K.R.D., and D.R. Flook. 1973. Background for managing grizzly bears in the national parks of Canada. Canadian Wildlife Service Report Series No. 22. Information Canada, Ottawa, Canada. 35 pp. (ADF&G-F)*

In this field research report, brown bears of all life stages in the national parks of the Rocky Mountains in Alberta and British Columbia, Canada, were studied during the spring, summer, and fall of 1961 and 1962. Additional data on bear-human encounters since 1939 are discussed, and some black bear information is incidentally included. The high elevation and mountainous terrain of the parks compensates for the more southerly latitude and produces habitat types comparable to those used by brown bears in Alaska: closed coniferous forests and open subalpine coniferous forests, alpine tundra, riparian areas and snowslide slopes. The activities of human disturbance and solid waste disposal were responsible for documented direct impacts of attraction to an artificial food source and active and passive harassment. Aspects of brown bear ecology are a major part of the article. The presence of garbage alters the natural movements of bears, which would normally take them away from main valley floors in early summer to alpine tundra, away from most humans. The behavior of back country travellers can also increase harassment of bears. Mitigative guidelines are 1) to install supplementary-heated incinerators of adequate capacity away from centers of human activity, 2) to install bear-proof garbage receptacles, 3) to pick up garbage every evening (before bears feed at night), 4) to release captured, tagged bears in areas closed to public use, 5) to locate campgrounds in areas outside heavily used brown bear habitat, 6) to assign special wilderness status to certain areas of grizzly range (without improved trails, shelters, or roads and with restricted access if necessary), 7) to advise hikers to avoid brown bear concentration areas, 8) to advise hikers to make noise, 9) to restrict dogs to visitor service areas, 10) to require hikers to pack out unburned garbage, and 11) to educate the public about bears.

Activity: human disturbance; solid waste disposal.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Pearson, A.M. 1980. The potential impact of the Dempster Lateral Gas Pipeline on grizzly bear and fox in the Mackenzie delta. Environmental rept. Prepared by Art Pearson and Associates for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 17 pp. (ADF&G-F)*

This review paper examines the information on arctic fox and grizzly bear in the Mackenzie River delta area, Northwest Territories, Canada, to allow further refinement of impact predictions on these two species by the construction of the Dempster Lateral Gas Pipeline. Information reviewed was primarily from the 1970's. Habitat within the area was described as a combination of sedge-herb and willow-sedge communities in lowland areas and dwarf shrub-heath in drier upland areas. The activity of grading and plowing created a documented direct impact of terrain destruction when a bear den was destroyed by a gravel-mining operation. The activity of drilling produced a documented direct impact of passive harassment. Conclusive results showed that bears rarely ventured closer than 1.0 km (0.6 mi) to drilling camps. The activity of transporting oil/gas/water by land could produce a potential indirect impact of increased level of harvest by providing a late winter travel route for native hunters seeking brown bears along the pipeline route. The author concluded that 1) gravel-mining sites must be chosen carefully to avoid or minimize disturbance to grizzly denning areas, 2) that activity at winter worksites located in or near denning areas should commence in September, before bears choose den sites, in an attempt to influence bears to select a den site that would not be disturbed by winter activity, 3) that human-bear conflicts could be minimized by safe storage of supplies, proper disposal of garbage, an environmental orientation program, and restrictions on firearms, and 4) that use of the pipeline right-of-way by people (including hunters) be controlled after the pipeline is operational.

Activity: drilling; grading/plowing.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); terrain alteration or destruction (e.g., raptor cliffs).

Quimby, R. 1974. Grizzly bear. In R.D. Jakimchuk, ed. Mammal studies in northeastern Alaska with emphasis within the Canning River drainage. Arctic Gas Biol. Rept. Ser., Vol. 24, Chap. 2. (UAF)

This field study was conducted during the period April through October 1973 in the Canning River drainage, northeastern Alaska. The purpose of the study was to determine the number of brown bears using the Canning River drainage, their home range, habitat use, food habits, movements, sex and age composition, denning areas, and responses to aircraft. Habitat types within the area were alpine, shrub, and coastal tundra. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Five of 10 bears apparently abandoned dens from 7 to 12 October after being followed to them by helicopter. Seventy percent of all bears reacted strongly (running or trotting) to aircraft and helicopters at elevations of 15 to 130 m (50 to 750 ft) above ground level. Severest reactions were in response to helicopters.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Reynolds, H.V., J.A. Curatolo, and R. Quimby. 1976. Denning ecology of grizzly bears in northeastern Alaska. Pages 403-409 in M.R. Pelton, J.W. Lentfer, and G.E. Folk, eds. Bears - their biology and management. IUCN Publ. New Ser. No. 40. Morges, Switzerland. (UAF)

The purposes of this field study were to locate dens, delineate denning habitat, and to determine if the availability of den sites was a population-limiting factor for brown bears within the eastern Brooks Range, Alaska. Denning was studied during April-November, 1973-1974. Habitat types within the study area consisted of alpine and shrub tundra. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Bears abandoned five den sites after they were tracked to them by helicopter. Bears appeared to be most prone to abandon dens when disturbed during or shortly after den construction. By approaching dens carefully and spending little time in the area, researchers could locate dens without causing abandonment.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Reynolds, P., H.V. Reynolds, III, and E.H. Follmann. 1983. Effects of seismic surveys on denning grizzly bears in northern Alaska. Draft paper presented at the sixth international conference on bear research and management. Bear Biol. Assoc. Grand Canyon, AZ. February, 1983. (ADF&G-F, Habitat)*

This paper reports the results of field research conducted in the northern foothills of the western Brooks range, Alaska, which recorded the responses of denning grizzly bears to noise associated with winter seismic surveys and small fixed-wing aircraft. Observations of denning bears were made between March 1978 and March 1980 when seismic crews were operating in the area, and in February 1981 when no seismic exploration activities took place. Additional information was collected in May and June 1980 and 1981 immediately before and after emergence of bears from their dens. Responses of bears to seismic activities and aircraft were measured from changes in signal amplitude and temperature of external radiocollars (three bears) and from implanted heart rate transmitters (two bears). Both adult male and female bears were monitored. Habitat within the study area is alpine and shrub tundra. The activities of drilling, blasting, and transporting personnel/equipment/material by air and land produced a documented direct impact of passive harassment. Tentative results indicated that female bears had increased heart rates and/or movements within their dens during seismic surveys, suggesting a reaction of these bears to vehicle noise and/or shot detonation 0.8 - 2.4 km (0.5-1.5 mi) from their dens. Fluctuations of radiocollar temperatures and amplitude suggested that vehicles drilling shot holes caused a greater response in one denning female bear than did seismic detonations. None of the observed bears deserted their dens as a result of seismic exploration activities. During aircraft overflights immediately prior to and shortly after emergence from dens, two females with cubs showed increased heart rates. Flights over these bears at times other than the den emergence period caused little change in heart rate. During aircraft overflights, an increase in heart rate was noted on several occasions without any obvious changes in behavior. Management recommendations included 1) a restriction on the operation of ground vehicles within 0.8 km (0.5 mi) of known bear dens, 2) restriction of flights of aircraft over known dens between May 1-15 to altitudes above 300 m (1,000 ft), and 3) restriction of flights over bears at other times of the year to altitudes above 150 m (500 ft).

Activity: blasting; drilling; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Schallenberger, A. 1980. Review of oil and gas exploitation impacts on grizzly bears. Pages 271-276 _in_ C.J. Martinka and K.L. McArthur, eds. Bears - their biology and management. Fourth international conference on bear research and management, Kalispell, MT, February 1977. (UAF)*

In this article, papers discussing the effects of activities associated with exploration and production of oil and gas deposits in brown bear habitat are reviewed. The articles were written between 1909 and 1977, the majority since 1960, and cover various seasons, geographic areas, and habitat types. The proposed development to which this article is addressed will occur in northwestern Montana in high-elevation, primarily mountainous terrain with habitat types of coniferous and aspen forests, grasslands, riparian zones, and alpine tundra comparable to grizzly habitat in southcentral and interior Alaska. The activities of drilling, grading/plowing, grazing, human disturbance, solid waste disposal, transportation of oil or gas by land, and transportation of personnel/equipment/material by air and land were cited as responsible for documented direct impacts of attraction to artificial food source, active and passive harassment, increase in harvest, and indirect impacts of competition with domestic livestock, alteration of prey base (through impacts on wild ungulates), vegetation composition change to less preferred or useable species (due to livestock grazing and fire suppression) and vegetation damage or destruction due to mechanical removal or material overlay. Discussion not related to a single reviewed paper includes the following: Conclusive results show that the major food plants for grizzlies in Yellowstone National Park are the same as those that are highly palatable to livestock and that decrease in abundance under livestock grazing. Fire suppression in developed areas results in climax forests less suitable as brown bear habitat than successional vegetation. Impacts to ungulate prey decrease food sources for bears and lead to predation of domestic livestock. In summary, available information indicates that the potential impacts of oil and gas exploitation should be considered primarily detrimental for brown bears in northwestern Montana. Cumulative impacts of road construction and human presence are the worst. Mitigative guidelines are 1) to lease lands for exploration only; then, if petroleum is found, to weigh the costs and benefits of extracting it, 2) to perform exploration for petroleum only once on a given land area and make the data public; 3) to establish pilot projects adjacent to existing roads, 4) to greatly restrict activities when brown bears make heavy seasonal use of an area; and 5) restrict secondary developments such as recreational cabins and subdivisions.

Activity: drilling; grading/plowing; grazing; human disturbance; solid waste disposal; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from; prey base, alteration of; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Schoen, J.W., L.R. Beier, and J.W. Lentfer. 1985. Denning ecology of coastal brown bears on Admiralty and Chichagof islands, Southeast Alaska. Draft paper for presentation at the seventh international conference on bear research and management. Bear Biol. Assoc., February 1986 (ADF&G-F, Habitat)*

This field study was conducted from the fall of 1981 through 1985 with the objectives of documenting brown bear denning chronology, delineating denning habitat and den site selection, assessing the availability of suitable den sites, and examining the relationships of resource developments to the denning ecology of brown bears. Bears of all ages and both sexes were studied. The study areas on Admiralty and Chichagof islands contain primarily mountainous terrain covered by temperate rain forest and alpine tundra. The activities of transporting personnel/equipment/material by air and grading and plowing produced documented direct impacts of harassment. Radio-collared bears instrumented with motion sensors became active in their winter dens when overflown by small fixed-wing aircraft at an altitude of about 150 m (500 ft). Tentative results indicated that six radio-collared female bears that denned within 4 km (2.5 mi) of a mine significantly increased their following years den's mean distance to the mine. Additionally, the mean distance between den sites in subsequent years was significantly greater for the 6 females closest to the mine (10.4 km [6.4 mi]) than for 11 females that denned outside the mine's influence (1.9 km [1.2 mi]). The area of the mine's influence was selected to be a 4 km (2.5 mi) radius. None of the males radio-collared in this study denned near the mine site or even with the drainage of the mine. The authors suspect that males (particularly adults) are more sensitive to human activity and avoid areas associated with humans more than do females. Recommendations included 1) curtailing of resource developments and extensive human activity in areas of known denning concentrations, 2) minimizing the use of heavy machinery, blasting, and aircraft during the denning period, particularly during den entry and emergence, and 3) avoiding or routing helicopter traffic away from den concentrations during periods of den entry and emergence. Hydroelectric development, mining, and in particular, logging, were discussed as potentially eliminating suitable denning habitat in Southeast Alaska.

Activity: grading/plowing; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sigman, M.J., ed. 1985. Impacts of clearcut logging on the fish and wildlife resources of southeast Alaska. ADF&G Habitat Division Tech. Rept. 85-3. 95 pp. Juneau. (ADF&G-F)*

This review article discusses the effects of clearcut logging on Sitka black-tailed deer, mountain goat, moose, brown and black bear, Bald Eagle, marten, mink, land otter, and red squirrel of all life stages, among other species. Most of the papers cited describe research done in southeast Alaska since 1970, but older publications and studies performed on the same species in other geographic areas where the habitat types and latitude are similar to those of southeast Alaska are also included. The studies were done at all seasons of the year. The habitat type is coastal temperate rain forest dominated by Sitka spruce, western hemlock, and other conifers. In addition to documented impacts, potential impacts life history, and habitat use information is presented for each wildlife species. Only documented impacts and recommendations made in the cited papers are summarized below by species. Management recommendations made by the author are generalizations of those made in the cited papers and are not repeated here.

Sitka black-tailed deer. The activity of clearing and tree harvest was responsible for th documented direct impact of barriers to movement, and for the documented indirect impacts of vegetation composition change to less preferred successional stage and vegetation damage or destruction due to mechanical removal. Dense shrubs and slash in clearcuts less than 15 to 40 years old precludes deer movement and use in summer, and in winter higher snow depths in clearcuts nearly prevent deer use and movement. Even in winters of little snow accumulation and in summer, deer avoid clearcuts and prefer mature old-growth forest habitats. Precommercial thinning may prolong understory production in stands prior to canopy closure, but any effect is short-lived and a two-layered conifer stand results. Deer populations have declined by 50 to 75% after clearcutting of areas on an near Vancouver Island, B.C. mitigation recommendations are to burn slash or clear trails through it for deer, to cease disproportionate harvest of high-volume old-growth timber, and to avoid harvesting old-growth stands with exceptional fish and wildlife values.

Mountain goat. The activities of clearing and tree harvest and human disturbance were responsible for the documented direct impact of harassment. The activities of grading/plowing (road construction) and transporting personnel/equipment/material by land were responsible for the documented direct impacts of barriers to movement, harassment, and change in harvest level. Logging, logging camps and associated human noise, and vehicle traffic disturb goat behavior and cause abandonment of preferred high quality summer range within and near the disturbances. The effects from logging camps have been documented within a 2 km radius and include increased mortality of goats. Construction of new roads has blocked goat movement and led to overharvest of previously less accessable populations. No recommendations based on documented impacts were made.

Moose. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. Although the high amount of forage in recent clearcuts is beneficial to moose in areas of southeast Alaska where riparian foreage is not abundant, as clearcuts become dominated by young conifers moose cease using them. During periods of deep snow, moose do not use even recent clearcuts but feed in high-volume old-growth and river terrace forests and in riparian shrub stands. Mitigation recommendations are to retain forests around and within high density feedings, breeding, and movement areas, and to retain any old growth river terrace or old-growth forests that are limited in extent in the era of concern as well as a portion of such forests even if they are not limited in extent.

Furbearers. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. No impacts on wolves were documented, only on an important prey species included in the AHMG, Sitka black-tailed deer (q.v.). Populations of marten decline when mature coniferous forests are clearcut, due to greatly decreased populations of red-backed voles, an important prey species, and due to loss of den sites in hollow trees and deadfalls. In winter, marten do not hunt in clearcuts but only in dense, mature coniferous forest stands. They will cross but will not hunt in openings greater than 91 m (300 ft) in width. No mitigation recommendations were made for marten. Mink made almost no use of clearcuts. Mitigation recommendations are to retain windfirm shoreline buffer strips at least 60 m (197 ft) inland from the shoreline. If shoreline forests must be clearcut, keep the length of shoreline cut as short as possible, never more than 0.8 km (0.5 mi), and avoid cutting shoreline timber on points and in other areas where narrow timber stands separate shorelines, along intertidal zones where the distance between the 0 and +6 m (+20 ft) lines are less than 40 m (131 ft) apart, and along intertidal areas with high exposure of bedrock and boulder cover. Land otters avoid using clearcuts for travel, burrows, or natal dens. Mitigation recommendations are to avoid logging adjacent to watercourses from early May to late summer (the breeding season) and to retain a windfirm fringe of forest 50 to 75 m (164 to 246 ft) wide along the beach to meet otter habitat requirements. Denning and feeding areas for red squirrels are eliminated by clearcutting. Red squirrels cannot utilize clearcuts until cone production by revegetating conifers is reestablished after 20 to 40 yr.

Brown Bear. References reviewed for impacts to brown bear included studies conducted in coastal forests and studies conducted in interior forests (e.g., Montana). The activity of clearing and tree harvest produced documented impacts of changes in vegetation composition to less preferred successional stages (e.g., changing old growth to even aged forest), vegetation damage and destruction due to mechanical removal, barriers to movements (e.g., extensive areas of slash), and harassment. The activity of grading (road building) produced a documented direct impact of harassment. The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source (i.e., garbage). The activity of human disturbance produced documented direct impacts of harassment and an increase in the harvest of bears (nuisance kills and increased access for hunters).

Bald Eagle. The activity of clearing and tree harvest produced a documented indirect impact of vegetation damage/destruction due to mechanical removal. Logging within 45 m (150 ft) of nest trees resulted in blowdown of nest trees at a rate 20 times more common than when logging occurred further than 45 m (150 ft) from the nest trees.

> Activity: clearing and tree harvest; grading/plowing; human disturbance; solid waste disposal.
>
> Impact: attraction to artificial food source; barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Smith, R.B., and L. Van Daele. 1984. Terror Lake hydroelectric project. Report on brown bear studies, 1982. ADF&G. Submitted to Alaska Power Authority. 110 pp. (ADF&G-F, Habitat)

This field study, conducted from March through December, 1982, was the first year of a five year study to monitor the impacts of the construction and operation of the Terror Lake hydroelectric project on brown bears. The Terror Lake project is located on northwestern Kodiak Island within habitat ranging from tide flats and river deltas to steep ridges and mountain peaks. Vegetation within the study area includes stands of alder, willow, and other shrubs, areas of grass or sedge, scattered birch, cottonwood and spruce, and alpine tundra. Brown bears of all life stages and both sexes were studied. The activities of human disturbance (non-project related) solid waste disposal and transport of personnel/equipment/material by land produced documented direct impacts of attraction to an artificial food source, passive harassment, and increase in level of harvest. Two radio-collared bears were killed after they became nuisances at the town dump in Port Lions and at a cannery dump in Uganik Bay, two areas near the Terror Lake project. One bear was suspected to have used the Terror Lake project garbage pit although no bears were directly observed at the pit. One female bear with cubs made several short charges at a bus that had stopped to allow workers to observe the bears. Tentative results suggest that some bears may have adopted a nocturnal pattern of feeding on salmon in the Kizhuyak River, possibly a response to disturbance by construction activities.

Activity: human disturbance; solid waste disposal; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Stelmock, J.J. 1981. Seasonal activities and habitat use patterns of brown bears in Denali National Park - 1980. M.S. Thesis, Univ. Alaska, Fairbanks. 118 pp. (UAF)

This field study was conducted during May-October, 1980, in Denali National Park, Alaska, and examined the daily and seasonal patterns of activity and the use of habitat by brown bears in two areas near the park road receiving high visitor use. Activity and habitat use patterns were recorded for single bears and for family groups. The habitat within the study area was shrub and alpine tundra. The activity of transporting personnel/equipment/material by land produced a documented direct impact of passive harassment. In spring, when a vehicle passed by, some individuals and family units ran or traveled continuously until out of sight of the road. Other single bears and family groups would feed near the road, with no strong reactions to passing vehicles. The intensity of reaction to vehicles decreased during the summer, but some individuals remained sensitive to vehicles and their noise. All bears reacted to loud noises made by vehicles within distances of up to 0.75 km (0.5 mi).

Activity: transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Tracy, D.M. 1977. Reactions of wildlife to human activity along Mount McKinley National Park Road. M.S. Thesis, Univ. Alaska, Fairbanks. 260 pp. (UAF)

This field study was conducted during the summers of 1973 and 1974 in Mt. McKinley National Park in central Alaska and focused primarily on brown bear, moose, caribou, Dall sheep, and red fox. Objectives of the study included describing the behavioral responses of the large mammals to various human activities and to determine the effects of human activities on the distribution of large mammals along the McKinley Park road. Habitat types within the study area were alpine tundra, moist tundra, and boreal forest. The activities of human disturbance and transport of personnel/equipment/material by land produced documented direct impacts of active and passive harassment. Conclusive results indicated fewer bears in study plots near the road compared to off-road study plots, suggesting that some bears may be avoiding roadside habitat. Single bears were less likely to be found near the road than were family groups. Responses of bears were similar for occasions when people remained in vehicles and when people disembarked yet remained close to the vehicle. The threshold distance where 50% of the bears exhibited strong responses occurred between 50 and 75 m (165 and 245 ft) from the road. One bear, encountering human scent on a trail in an off-road study area, responded by running at least 4 km (2.5 mi).

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

USDI. 1976a. Final environmental impact statement. Pages 322-329 and 501-504 in Alaska natural gas transportation system. Washington, D.C. (ARL) #

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

(1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.

(2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.

(3) Muskoxen may have shifted their traditional summer range by 26 km (16 mi) in response to heavy helicopter traffic.

(4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.

(5) Muskoxen and Canada geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

(1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.

(2) Caribou can apparently tolerate winter blasting if they are not hunted.

(3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.

(4) Waterfowl with young avoid drilling rigs within a 4.3 km (2.6 mi) radius.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Zager, P.E. 1980. Timber harvest, wildfire, and grizzly bears in Northwestern Montana. Paper presented at the fifth international conference on bear research and management. Bear Bio. Assoc. Madison, WI. (ADF&G-F, Game)#

The effects of wildfire and logging on the abundance and distribution of grizzly bear foods was studied in northwestern Montana from 1977 through 1979. Phytosociological data were collected from 48 logged sites, 75 burns, and 95 old-growth sites known to be used by grizzlies.

Habitat utilization studies indicate a significant avoidance of clear-cuts by grizzlies, and on-the-ground investigations reveal substantial utilization of certain logged units. Utilized clear-cuts tended to be along secondary or closed system roads. Use of cuts along primary system roads was restricted to that portion of the cut farthest removed from the road. In most cases, there was escape cover within 50-75 m (165-245 ft).

Large burned areas were not a barrier to grizzly movement, particularly at high elevations, where food production is often good, adequate cover is generally present, and human access is limited.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Zager, P.E., and C.J. Jonkel. 1983. Managing grizzly bear habitat in the northern Rocky Mountains. J. Forestry 81(8):524-526, 536. (UAF)*

In this review and discussion article, management recommendations with respect to land and resource development are presented for brown bears of all life stages in the northern Rocky Mountains of Montana, Idaho, and Washington states. Several studies of brown bear ecology in the geographic area of interest are reviewed. Although the area is south of Alaska, habitat types at the elevations used by brown bears are similar to those found in Alaska: closed and open subalpine coniferous forests, riparian areas, snowslides, and alpine tundra. The activities of clearing and tree harvest, drilling, grading and plowing, grazing, human disturbance, solid waste disposal, and transporting personnel/equipment/material by land are responsible for documented direct impacts of attraction to artificial food source (garbage and cattle), active and passive harassment, and change in harvest level. Indirect impacts include competition with introduced domestic species (cattle), vegetation composition change to less preferred or useable species (grazing, logging, and fire suppression), vegetation damage or destruction due to grazing, vegetation damage or destruction due to mechanical removal or material overlay (scarification, road construction, drilling, mining), and terrain alteration or destruction (dens). Detailed, useful management guidelines are included for all of the above activities.

Activity: clearing and tree harvest; drilling; grading/plowing; grazing; human disturbance; solid waste disposal; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; terrain alteration or destruction (e.g., raptor cliffs); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Zager, P., C. Jonkel, and J. Habeck. 1983. Logging and wildfire influence on grizzly bear habitat in northwestern Montana. Pages 124-132 in E.C. Meslow, ed. Bears - their biology and management. Fifth international conference on bear research and management, Madison, WI, February 1980. (UAF)*

In this field research report, brown bears of all life stages except those in dens were intensively studied, along with their habitat, along the Flathead River, northwestern Montana, and less intensively in adjacent areas of Montana and British Columbia from June through September of 1976 through 1979. Although the study area is at a more southerly latitude than Alaska, the high elevation and mountainous terrain near the continental divide result in comparable habitat types dominated by spruce and subalpine fir forests. The activities of burning, clearing and tree harvest, and grading/plowing resulted in documented indirect impacts of vegetation composition change to less preferred or useable species, vegetation damage or destruction due to fire, and vegetation damage or destruction due to mechanical removal. Barriers to movement are documented in an unpublished paper cited in this report. Conclusive results show that shrubs providing food and cover for brown bears readily resprout after fire and that effective wildfire suppression has already had a significant negative impact on grizzly bear habitat and food production on mesic sites and will probably result in declining food production on high elevation sites as well. Clear-cuts in which slash has been piled and burned and the soil scarified provide very little bear food, and clear-cuts in which no slash collection or scarification was performed produced amounts of foods intermediate between mature forests and areas burned by wildfires. Extreme concentrations of slash such as found in coastal British Columbia are cited as making travel difficult for bears. Brown bears avoided clear-cut areas, except when using overgrown skid roads as means of travel in areas without primary roads. Increased human disturbance associated with primary roads effectively removed a large portion of these units as suitable bear habitat. Of clear-cut areas used by bears, 56% of radio locations were within 25 m (80 ft) of escape cover and 82% were within 50 m (165 ft). Proximity to escape cover was more important for use by brown bears than clear-cut size. Management recommendations made in the text include the following: 1) clear-cut log using high lead yarding rather than with ground vehicles, do not scarify, and broadcast burn slash; and 2) retain stringers of uncut forest as travel corridors, especially along creeks and between harvested patches.

Activity: clearing and tree harvest; drilling; grading/plowing; grazing; human disturbance; solid waste disposal; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; terrain alteration or destruction (e.g., raptor cliffs); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

10. Caribou

10. CARIBOU

Two technical reports presenting a detailed discussion of the impacts of human land use and developments on caribou have been prepared in lieu of the standard impacts section. These reports are:

Shideler, R.T., M.H. Robus, J.F. Winters, and M. Kuwada. 1986. Impacts of human developments and land use on caribou: a literature review. Volume I. A worldwide perspective. Tech. Rept. 86-2. Div. Habitat. ADF&G, Juneau.

Shideler, R.T. 1986. Impacts of human developments and land use on caribou: a literature review. Volume II. Impacts of oil and gas development on the Central Arctic Herd. Tech. Rept. 86-3. Div. Habitat. ADF&G, Juneau. 128 pp.

11. Dall Sheep

Table 1. Impacts Associated With Each Activity - Dall sheep

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source				X	X							X													X			X		
Barriers to movement, physical and behavioral			X		X				X			X		?					?						X			X		?
Collision with vehicles or structures																												X		
Entanglement in fishing nets, debris					?				X																					
Entrapment in impoundments or excavations			X									?										?			X			?		X
Harassment, active or passive	X				X			X			?	X	X	X					X	?	X	?			X		X	X		?
Harvest, change in level								?				?	?						?						?			X		
Introduced wild/domestic species, competition				X									X	X														X		
Morbidity/mortality by ingestion of petroleum				?				?												?					?					
Parasitism/predation, increased susceptibility					X				X			X	X	X					?						?		X	?		
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction	?										?	X							?			?			X					?
Veg. composition, change to less preferred		X			X							X	X						?											?
Veg. damage/destruction due to air pollution				?															?	?										
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion		?			X						?	X							?			?								
Water level or water quality fluctuations			?									?	X						?		?									X

X - Documented impact (see text).
? - Potential impact.

11. DALL SHEEP - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on Dall sheep. Each citation refers to an annotation in the following section, Annotated References to Impacts on Dall sheep. Table 1 is a quick index to the impacts and activity for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impacts categories which are not relevant to Dall sheep are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to Dall sheep were found for the following activities:

Burning
Dredging
Log storage/transport
Processing geothermal energy
Processing oil/gas
Solid waste disposal
Transport of oil/gas/water - water

Activities definitions and the list of impacts categories are located in appendix C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Graf 1980
      Pendergast et al. 1974
      USDI 1976a

2. Channelizing waterways:

   a. Barriers to movement, physical and behavioral

      Graham 1980

   b. Entrapment in impoundments or excavations

Graham 1980

3. Chemical application:

    a. Attraction to artificial food source

        Samuel et al. 1975

    b. Introduced wild/domestic species, competition

        Blood 1971
        Samuel et al. 1975

4. Clearing and tree harvest:

    a. Attraction to artificial food source

        Ellis et al. 1978
        Geist 1971a

    b. Barriers to movement, physical and behavioral

        Millar 1983

    c. Harassment, active or passive

        DeForge 1972
        Light 1971

    d. Parasitism/predation, increased susceptibility

        Woodard et al. 1974

    e. Veg. composition, change to less preferred

        Elliott 1983

    f. Veg. damage/destruction due to erosion

        Millar 1983

5. Drilling:

    a. Harassment, active or passive

        Geist 1971a

6. Fencing:

   a. Barriers to movement, physical and behavioral

      Buechner 1960
      Graf 1980
      Graham 1980
      Hansen 1971
      Helvie 1971
      Packard 1946

   b. Entanglement in fishing nets, debris

      Graham 1980
      Hansen 1971
      Helvie 1971

   c. Parasitism/predation, increased susceptibility

      Buechner 1960
      Packard 1946

7. Grading/plowing:

   a. Attraction to artificial food source

      Elliott 1983
      Goodson 1982
      Jakimchuk et al. 1984
      McCrory 1975
      McKendrick et al. 1984
      Riggs and Peek 1980

   b. Barriers to movement, physical and behavioral

      Geist 1971a
      Millar 1983

   c. Harassment, active or passive

      Geist 1975
      Graf 1980
      Hicks and Elder 1979
      Packard 1946

   d. Parasitism/predation, increased susceptibility

      Packard 1946
      Woodard et al. 1974

e. Terrain alteration or destruction

Graf 1980

f. Veg. composition, change to less preferred

Elliott 1983

g. Veg. damage/destruction due to erosion

Graf 1980
Hansen 1971
McKendrick et al. 1984
Millar 1983
Packard 1946

8. Grazing:

a. Harassment, active or passive

Buechner 1960
Goodson 1982

b. Introduced wild/domestic species, competition

Blood 1971
Bodie and Hickey 1980
Buechner 1960
Dieterich et al. 1981
Foreyt and Jessup 1982
Goodson 1982
Graham 1980
Hansen 1971
Hoefs and Brink 1978
Howe et al. 1966
Klebesadel and Restad 1981
McCollough et al. 1980
Packard 1946
Post 1971
Preston 1983b
Robinson et al. 1967
Samuel et al. 1975
Smith et al. 1982

c. Parasitism/predation, increased susceptibility

Buechner 1960
Hansen 1971
Packard 1946

Woodard et al. 1974

d. Veg. composition, change to less preferred

Bodie and Hickey 1980
Demarchi 1970

e. Veg. damage/destruction due to grazing

Bodie and Hickey 1980
Buechner 1960
Demarchi 1970
Graham 1980
Hansen 1971
Hoefs and Brink 1978
Packard 1946
Post 1971
Stevens 1982

f. Water level or water quality fluctuations

Hansen 1971

9. Human disturbance:

a. Harassment, active or passive

Andersen and Klein 1971
Buechner 1960
Campbell and Remington 1981
DeForge 1972
Dunaway 1971
Geist 1971a
Geist 1975
Graf 1980
Graham 1971
Graham 1980
Hansen 1971
Heimer 1978
Hicks and Elder 1979
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Leslie and Douglas 1980
Light 1971
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Packard 1946

Price and Lent 1972
Stemp 1982
Stevens 1982
Tracy 1977

b. Introduced wild/domestic species, competition

Geist 1971a

c. Parasitism/predation, increased susceptibility

Buechner 1960
Packard 1946
Wishart et al. 1980

10. Processing minerals (including gravel):

a. Harassment, active or passive

Geist 1975

11. Sewage disposal:

a. Harassment, active or passive

Graham 1980

12. Transport of oil/gas/water - land, ice:

a. Attraction to artificial food source

Jakimchuk et al. 1984
Leslie and Douglas 1980
McCrory 1975

b. Barriers to movement, physical and behavioral

Graf 1980
Graham 1980

c. Entrapment in impoundments or excavations

Graham 1980

d. Harassment, active or passive

Campbell and Remington 1981

Graf 1980
Leslie and Douglas 1980
McCourt et al. 1974
Reynolds 1974
USDI 1976a

e. Terrain alteration or destruction

Graf 1980

13. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Geist 1971a
Graham 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Krausman and Hervert 1983
Lenarz 1974
Linderman 1972
MacArthur et al. 1979
MacArthur et al. 1982
McCourt et al. 1974
Nette et al. 1984
Nichols and Heimer 1972
Pitzman 1970
Price and Lent 1972
Reynolds 1974
Singer and Mullen 1981
Stemp 1982
USDI 1976a

b. Parasitism/predation, increased susceptibility

Nette et al. 1984

14. Transport of personnel/equipment/material - land, ice:

a. Attraction to artificial food source

Ellis et al. 1978
Geist 1971a
Jakimchuk et al. 1984
Samuel et al. 1975

b. Barriers to movement, physical and behavioral

Geist 1971a
Graf 1980
Graham 1980
Hansen 1971
Horejsi 1976
Jorgensen 1974
Millar 1983
Stevens 1982
Tracy 1977

c. Collision with vehicles or structures

Geist 1971a
Graham 1980
Hansen 1971
Jakimchuk et al. 1984
Millar 1983

d. Harassment, active or passive

DeForge 1972
Geist 1971a
Graf 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Millar 1983
Packard 1946
Price and Lent 1972
Stevens 1982
Tracy 1977

e. Harvest, change in level

Geist 1971a
Graf 1980
Hansen 1971
Jakimchuk et al. 1984
Packard 1946

f. Introduced wild/domestic species, competition

Geist 1971a

15. Water regulation/withdrawal/irrigation:

a. Barriers to movement, physical and behavioral

Graf 1980
Graham 1980

b. Entrapment in impoundments or excavations

Graham 1980

c. Harassment, active or passive

Graf 1980

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to Dall sheep were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Morbidity/mortality by ingestion of petroleum
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Chemical application

      Samuel et al. 1975

   b. Clearing and tree harvest

      Ellis et al. 1978
      Geist 1971a

   c. Grading/plowing

      Elliott 1983
      Goodson 1982
      Jakimchuk et al. 1984
      McCrory 1975
      McKendrick et al. 1984
      Riggs and Peek 1980

   d. Transport of oil/gas/water - land, ice

      Jakimchuk et al. 1984
      Leslie and Douglas 1980
      McCrory 1975

   e. Transport of personnel/equipment/material - land, ice

      Ellis et al. 1978
      Geist 1971a

Jakimchuk et al. 1984
Samuel et al. 1975

2. Barriers to movement, physical and behavioral:

   a. Clearing and tree harvest

      Millar 1983

   b. Fencing

      Buechner 1960
      Graf 1980
      Graham 1980
      Hansen 1971
      Helvie 1971
      Packard 1946

   c. Grading/plowing

      Geist 1971a
      Millar 1983

   d. Transport of oil/gas/water - land, ice

      Graf 1980
      Graham 1980

   e. Transport of personnel/equipment/material - land, ice

      Geist 1971a
      Graf 1980
      Graham 1980
      Hansen 1971
      Horejsi 1976
      Jorgensen 1974
      Millar 1983
      Stevens 1982
      Tracy 1977

   f. Water regulation/withdrawal/irrigation

      Graf 1980
      Graham 1980

3. Collision with vehicles or structures:

   a. Transport of personnel/equipment/material - land, ice

Geist 1971a
Graham 1980
Hansen 1971
Jakimchuk et al. 1984
Millar 1983

4. Entanglement in fishing nets, debris:

    a. Fencing

        Graham 1980
        Hansen 1971
        Helvie 1971

5. Entrapment in impoundments or excavations:

    a. Transport of oil/gas/water - land, ice

        Graham 1980

    b. Water regulation/withdrawal/irrigation

        Graham 1980

6. Harassment, active or passive:

    a. Blasting

        Graf 1980
        Pendergast et al. 1974
        USDI 1976a

    b. Clearing and tree harvest

        DeForge 1972
        Light 1971

    c. Drilling

        Geist 1971a

    d. Grading/plowing

        Geist 1975
        Graf 1980
        Hicks and Elder 1979
        Packard 1946

e. Grazing

Buechner 1960
Goodson 1982

f. Human disturbance

Andersen and Klein 1971
Buechner 1960
Campbell and Remington 1981
DeForge 1972
Dunaway 1971
Geist 1971a
Geist 1975
Graf 1980
Graham 1971
Graham 1980
Hansen 1971
Heimer 1978
Hicks and Elder 1979
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Leslie and Douglas 1980
Light 1971
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Packard 1946
Price and Lent 1972
Stemp 1982
Stevens 1982
Tracy 1977

g. Processing minerals (including gravel)

Geist 1975

h. Sewage disposal

Graham 1980

i. Transport of oil/gas/water - land, ice

Campbell and Remington 1981
Graf 1980
Leslie and Douglas 1980
McCourt et al. 1974
Reynolds 1974
USDI 1976a

j. Transport of personnel/equipment/material - air

Geist 1971a
Graham 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Krausman and Hervert 1983
Lenarz 1974
Linderman 1972
MacArthur et al. 1979
MacArthur et al. 1982
McCourt et al. 1974
Nette et al. 1984
Nichols and Heimer 1972
Pitzman 1970
Price and Lent 1972
Reynolds 1974
Singer and Mullen 1981
Stemp 1982
USDI 1976a

k. Transport of personnel/equipment/material - land, ice

DeForge 1972
Geist 1971a
Graf 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Millar 1983
Packard 1946
Price and Lent 1972
Stevens 1982
Tracy 1977

l. Water regulation/withdrawal/irrigation

Graf 1980

7. Harvest, change in level:

a. Transport of personnel/equipment/material - land, ice

Geist 1971a

Graf 1980
Hansen 1971
Jakimchuk et al. 1984
Packard 1946

8. Introduced wild/domestic species, competition:

a. Chemical application

Blood 1971
Samuel et al. 1975

b. Grazing

Blood 1971
Bodie and Hickey 1980
Buechner 1960
Dieterich et al. 1981
Foreyt and Jessup 1982
Goodson 1982
Graham 1980
Hansen 1971
Hoefs and Brink 1978
Howe et al. 1966
Klebesadel and Restad 1981
McCollough et al. 1980
Packard 1946
Post 1971
Preston 1983b
Robinson et al. 1967
Samuel et al. 1975
Smith et al. 1982

c. Human disturbance

Geist 1971a

d. Transport of personnel/equipment/material - land, ice

Geist 1971a

9. Parasitism/predation, increased susceptibility:

a. Clearing and tree harvest

Woodard et al. 1974

b. Fencing

Buechner 1960
Packard 1946

c. Grading/plowing

Packard 1946
Woodard et al. 1974

d. Grazing

Buechner 1960
Hansen 1971
Packard 1946
Woodard et al. 1974

e. Human disturbance

Buechner 1960
Packard 1946
Wishart et al. 1980

f. Transport of personnel/equipment/material - air

Nette et al. 1984

10. Terrain alteration or destruction:

a. Grading/plowing

Graf 1980

b. Transport of oil/gas/water - land, ice

Graf 1980

11. Veg. composition, change to less preferred:

a. Clearing and tree harvest

Elliott 1983

b. Grading/plowing

Elliott 1983

c. Grazing

Bodie and Hickey 1980

Demarchi 1970

12. Veg. damage/destruction due to grazing:

    a. Grazing

        Bodie and Hickey 1980
        Buechner 1960
        Demarchi 1970
        Graham 1980
        Hansen 1971
        Hoefs and Brink 1978
        Packard 1946
        Post 1971
        Stevens 1982

13. Veg. damage/destruction due to erosion:

    a. Clearing and tree harvest

        Millar 1983

    b. Grading/plowing

        Graf 1980
        Hansen 1971
        McKendrick et al. 1984
        Millar 1983
        Packard 1946

14. Water level or water quality fluctuations:

    a. Grazing

        Hansen 1971

ANNOTATED REFERENCES TO IMPACTS TO DALL SHEEP

The annotated bibliography contains only references that discuss documented impacts to Dall sheep. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to Dall sheep are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Andersen, R., and D.R. Klein. 1971. Effect of human disturbance on Dall sheep. Alaska Coop. Wildl. Res. Unit, Univ. Alaska, Fairbanks. Quart. Rept. 22(3):23-27. (ADF&G-F)*

This is a preliminary report on this project, which was conducted in the Atigun River canyon of the central Brooks Range. The final report is annotated as Price and Lent 1972 and contains all the information on impacts in this article except the following. Passive harassment by individual humans or pairs of humans during the activity of human disturbance resulted in the following documented responses: A single person in plain sight could usually approach rams to within 15 m (50 ft) but ewes and young sheep only to 61 m (200 ft). In contrast, sheep usually ran from a pair of humans 91 m (300 ft) or more away.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Blood, D.A. 1971. Contagious ecthyma in Rocky Mountain bighorn sheep. J. Wildl. Manage. 35(2):270-275. (UAF)

In this field and lab research report and historical review paper, bighorn sheep of all life stages in western Alberta and eastern British Columbia were observed since 1953 for symptoms of contagious ecthyma (CE), a cosmopolitan viral disease of domestic sheep and goats. Dall sheep are known to contract CE, and the alpine tundra habitat of Rocky Mountain bighorns is similar to Alaska's alpine tundra. The activities of previous grazing of domestic sheep and ongoing chemical application (salt blocks) are suspected as the means by which CE was introduced and is maintained in wild sheep. The documented direct impact was that of disease transmission from domesticated animals. In the past, domestic sheep were grazed throughout the eastern flank of the Rocky Mountains, where all infected bighorn herds occur. All infected bighorn bands have also had, and still have, frequent and lengthy contact with salt blocks. CE has been conclusively proven in adult bighorns and lambs. In the latter, the disease is more severe, and emaciation and secondary infections can lead to death. Spontaneous healing usually occurs.

Activity: chemical application; grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Bodie, W.L., and W.D. Hickey. 1980. Response of wintering bighorn sheep to a rest-rotation grazing system in central Idaho. Pages 60-69 in W.O. Hickey, chairman. Proceedings of the biennial symposium of the northern wild sheep and goat council, Salmon, ID. April 23-25. (ADF&G-F, W. Heimer)

In this field research study, use of winter range by bighorns of all life stages in the Morgan Creek area of central Idaho was determined once each winter during the most critical period of winter severity between 1973 and 1979 and correlated with areas in which domestic livestock had been grazed during the previous summers. Bighorn sheep are closely related to Dall sheep. Although the study area is located south of Alaska and the habitat types of arid high desert sage-grass stands and grasses among other shrubs and coniferous trees are not comparable to alpine tundra used by Dall sheep in Alaska, the latter ranges have not yet been grazed by domestic animals, and the results are expected to be similar. The activity of grazing of domestic sheep and cattle was responsible for the documented indirect impacts of competition for forage, vegetation composition change, and vegetation damage. Prior to this study, and in the first 3 yr of this study, season-long grazing by domestic livestock had increased sagebrush domination of grasslands, forcing bighorns to winter on areas not used by livestock. Over a 7 yr period, the bighorn population had decreased from 250 to 100 sheep. After 4 yr of a three-pasture rest-rotation grazing system for livestock plus closure of critical bighorn winter range to livestock, the bighorn population stabilized. Tentative results, as range use shifts are continuing, are that bighorns prefer late use livestock pastures over areas closed to domestic livestock and over early use and rest pastures. The late use treatment increased fall regrowth of the preferred forage grass. Livestock grazing under a rest-rotation system is not necessarily detrimental to bighorn sheep ranges.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals.

Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present and future. Wildl. Monogr. 4. The Wildl. Soc. May. 174 pp. (UAF)*

In this major review paper and field research report on work done in the summer of 1954 and the spring and summer of 1955, bighorn sheep of all life stages throughout the continguous 48 states are discussed in relation to diseases, competition from livestock, and human harvest, among other topics. Bighorns have been affected by several human activities to which Dall sheep have not yet been subjected. In these cases, Dall sheep are expected to respond similarly to bighorns, in spite of the fact that they utilize different habitat types. The activities of fencing, grazing, and human disturbance are responsible for the historically documented direct impacts of barriers to movement (use of winter range), competition with introduced domestic animals, disease transmission from domesticated animals, active and passive harassment, excessive harvest, increased susceptibility to parasitism and disease, and vegetation damage or destruction due to grazing by domestic animals. Indirect impacts include increased competition with wild ungulates (deer and elk) that are also forced onto the same limited winter range. Several factors, all related to man and usually interacting, were responsible for the 100-fold decline in bighorn sheep populations between about 1850 and 1900: excessive market hunting, the disease of scabies (contradicted by Post 1970), competition with domesticated animals for space and forage and vegetation destruction by livestock (including domestic sheep, cattle, horses and burros) on summer and winter ranges, and restriction of winter range. Mitigation guidelines include 1) sensible harvest of sheep of both sexes in the few herds subject to overpopulation; 2) elimination of grazing of important sheep winter ranges by horses; 3) elimination of feral burros; 4) restriction of grazing by domestic sheep and cattle on important winter and summer ranges; and 5) reduction of certain elk and mule deer populations to decrease competition on winter ranges. The latter four guidelines are essential because of serious and increasing damage to native vegetation due to overgrazing.

Activity: fencing; grazing; human disturbance.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from; parasitism and predation, increased susceptibility to; vegetation damage/destruction due to grazing by domestic or introduced animals.

Campbell, B., and R. Remington. 1981. Influence of construction activities on water-use patterns of desert bighorn sheep. Wildl. Soc. Bull. 9(1): 63-65. (UAF)

In this field research study, desert bighorn sheep of all life stages in the Buckskin Mountains of Arizona, an area of mesas with Sonoran desert open vegetation of shrubs, cacti, herbs and grasses, were studied at water sources during the summers of 1978 and 1979. Although this habitat is not comparable to the Alaskan alpine tundra utilized by Dall sheep, water sources are critical point habitats comparable to mineral licks. Wild mountain sheep of different species are similar in behavior toward humans. The activities of transporting water by land and human disturbance were responsible for documented direct impact of passive harassment. During construction, sheep changed from energetically more efficient morning and frequent opportunistic use of a water source to brief, infrequent use in very early morning or late evening when construction was not occurring. The ewe:lamb ratio was unusually low in the construction year, tentatively indicating a long-term decrease in population viability because of increased energy expenditure by sheep.

Activity: human disturbance; transport of oil/gas/water - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

De Forge, J.R. 1972. Man's invasion into the bighorn's habitat. Desert Bighorn Council Trans. 16:112-115. (UAF)*

In this field research study on bighorn sheep of all life stages conducted from February through November 1971 in the South Fork of Lytle Creek, San Gabriel Mountains, Southern California, the effect of logging, motorized vehicle travel, and humans on foot using a restricted dirt road was observed. Bighorn sheep are closely related and behaviorally similar to Dall sheep. Although the study area is located south of Alaska and the habitat types of mixed coniferous forest, subalpine meadows, and cliffs are different from those in Alaska, the open character of the terrain is similar, and the effects of human activities on sheep are expected to be similar as well. The activities of logging, human disturbance, and use of motorbikes resulted in the documented direct impact of harassment. Sheep were observed in a lambing and year-round use area traversed by the road in February and March, when the road was not being used by humans. From April through June, first a logging operation, a short way (no distance stated) from the lambing area, then heavy weekend use of the road by motorbikes caused sheep to leave the valley. Two months after enforced closure of the road during the fire season, sheep began returning to and staying in the area, eventually bedding down on the road. The first sheep to return left upon sighting the investigator; subsequent sheep remained. Sheep again abandoned the area late in September when numerous deer hunters cut through the locked gate and used the road. The mitigation guideline proposed is to totally remove the road through the lambing area.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Demarchi, D.A. 1970. Bighorn sheep and overgrazing in the lower Chilcotin River region, British Columbia. Pages 39-45 in Transactions of the northern wild sheep council, Williams Lake, May 26-28, 1970. Wildl. Manage., British Columbia Fish and Wildl. Branch. (ADF&G-F, W. Heimer)

In this field research project, the effects of overgrazing by domestic cattle on the range of bighorn sheep of all life stages were studied between June 1968 and August 1969 in the lower Chilcotin River region of British Columbia. Bighorn sheep are closely related to Dall sheep and are expected to respond similarly to overgrazing. Although the study area is located south of Alaska and the habitat type of high elevation northern shortgrass prairie is not comparable to alpine tundra habitat of Dall sheep in Alaska, overgrazing would similarly damage alpine tundra vegetation. The activity of grazing domestic cattle was responsible for the documented indirect impacts of vegetation composition change and vegetation damage due to grazing. Overgrazing of the major habitat type occupied by bighorn sheep, Agropyron/Poa grasslands, by domestic cattle greatly reduced the amount of the two dominant climax grass species preferred by sheep and allowed weedy forbs to invade and become established. Bighorn lamb mortality was 50% between August and Novemeber, and no measurable lamb mortality occurred between November and March. The total bighorn population decreased by 35% during the 1-yr study.

Activity: grazing.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals.

Dieterich, R.A., G.R. Spencer, D. Berger, A.M. Gallina, and J. Vander Schalie. 1981. Contagious ecthyma in Alaskan musk-oxen and Dall sheep. J. Am. Vet. Med. Assoc. 179(11):1,140-1,143. (UAF)

In this lab research report, Dall sheep and musk oxen at all life stages in captive herds near Fairbanks, Alaska were studied from the fall of 1976 through the fall of 1977. References to Rocky Mountain goats near Ketchikan, Alaska, are also made. Although the sheep and musk oxen herds were not in their natural habitat, and close confinement may have facilitated the spread of disease, the fact of susceptibility remains valid. The activity of grazing was most likely responsible for the documented direct impact of disease transmission from domesticated animals. Virtually all animals in both the muskox and Dall sheep herds were infected by contagious ecthyma (CE), probably spread from a domestic farm animal. Some lambs and yearlings died. Biopsies conclusively proved CE as the infectious agent. Similar lesions have been reported from free-living Rocky Mountain goats near Ketchikan, Alaska; the original source of that infection is not discussed.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Dunaway, D.J.. 1971. Human disturbance as a limiting factor of Sierra Nevada bighorn sheep. Pages 165-173 in E. Decker, ed. Transactions of the First North American wild sheep conference, Colorado State Univ., April 14-15, Fort Collins, Colorado. 187 pp. (UAF)*

In this brief review and discussion article, population declines of bighorn sheep of all life stages in the Sierra Nevada of California between 1949 and 1970 are described. The open subalpine coniferous forest and alpine tundra habitat of California bighorns is similar in general appearance to Dall sheep habitat in Alaska, and the two sheep species respond similarly to human disturbance. The activity of human disturbance is strongly implicated (though not experimentally proven) as being responsible for the direct impact of passive harassment. In this 20-year period, sheep populations have declined nearly 50% in the absence of normal limiting factors of low range quality, hunting or poaching, predation, competition from livestock (but see comment below), competition from other ungulates, or diseases or parasites. Gaps in the previously continuous distribution of sheep and populations that showed greatest declines are strongly associated with areas of heaviest backpacker use, implicating human disturbance as a major limiting factor. Although not explicitly stated or recommended, it is strongly suggested that land managers limit human disturbance to allow the sheep to survive.

[Reviewers note: These conclusions were not fully corroborated by Hicks and Elder (1979) in a follow-up study. The presence of livestock grazing leases on alluvial fans just below rugged terrain now used by bighorns as winter range is dismissed by the author, but bighorns are known to avoid winter range used by livestock and may have been forced onto much less productive winter ranges, resulting in low recruitment. Lamb production and survival is not discussed.]

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Elliott, C. 1983. Food habits and habitat characteristics of wildlife species utilizing revegetated strip mine lands in Alaska. Exhibit IV-5 in Poker Flats mine permit application, Usibelli Coal Mine. June. (ADF&G-F) *

In this field research report, the effects of revegetation of strip mined lands near Healy, Alaska, on all life stages of 26 species of mammals and birds, including coyote, fox, moose, sheep, and wolf, during all seasons of the year from 1980 to 1982 were examined. Undisturbed habitat types in this area of the northern foothills of the Alaska Range included open and closed spruce forest, shrub tundra, and barren floodplain. Areas disturbed 33 to 40 yr before the study had naturally revegetated to tall shrub habitat; other areas had been revegetated to grasses in 1972, 1976, and 1979. The activities of grading/plowing, human disturbance, and transport of personnel/equipment/material by land were responsible for documented direct impacts of attraction to artificial food source and passive harassment and the indirect impact of alteration of prey base. Potential impacts are also discussed. Conclusive results by species follow, then mitigation guidelines for all species.

Carnivorous furbearers. The absence of hares in areas revegetated to grasses has decreased prey availability for coyotes and, to a lesser degree, for wolves and foxes. Wolves avoid hunting in areas of frequent human presence but seek Dall sheep grazing in a revegetated area in winter.

Moose. Summer and winter browsing areas for moose have been eliminated in areas revegetated to grasses, whereas shrub stands in naturally revegetated roadsides and mined areas attract moose.

Sheep. One mined area that includes revegetated grass stands near a steep headwall and that winds keep snow-free provides low-quality sheep winter range, used in conjunction with natural tundra.

Mitigation guidelines for wildlife in general, including birds and small mammals, are 1) promote a diversity of vegetation on areas to be mined and eventually reclaimed, by reserving areas such as riparian shrub zones and by avoiding reseeding to monotypic grass stands; 2) construct haul roads with as low a berm as possible; 3) place uprooted trees and brush in piles adjacent to undisturbed areas (as cover); 4) reseed disturbed areas to native plants; and 5) if seeding to grasses must be done to control erosion, use red fescue (Festuca rubra) and bluejoint (Calamagrostis canadensis), the species most beneficial to wildlife.

Activity: clearing and tree harvest; grading/plowing.

Impact: attraction to artificial food source; vegetation composition, change to less preferred or useable species.

Ellis, E.H., J.G. Goodwin, Jr., and J.R. Hunt. 1978. Wildlife and electric power transmission. Pages 81-104 in J.L. Fletcher and R.G. Busnel, eds. Effects of noise on wildlife. New York: Academic Press. (ARL)#

The potential effects of powerlines and rights-of-way are described. Construction and maintenance activities may cause displacement of wildlife. Wildlife avoidance of powerline corridors has been little studied. No published studies are known on the response of wildlife species to powerlines. Collisions with wires have been documented for many species of birds. These generally involve few birds but can be serious mortality factors in some cases. Legal and illegal hunting increase deer and elk mortality along rights-of-way and transmission line access roads, especially in previously unroaded areas. Raptors perched on utility poles are particularly vulnerable. Studies indicate that hunters concentrate along roads and cleared trails, and this has been shown to affect elk movement. Benefits of power lines include increased food for deer, elk, bighorn sheep, and black bear along corridors and additional perches and nest sites for raptors. Research in Idaho and Montana showed that a transmission line did not make a right-of-way less attractive to deer and elk feeding in the cleared area during early spring. No significant difference in big game use of rights-of-way and a control clearing was noted. Elk and deer showed no apparent hesitation in crossing the corridor.

Activity: clearing and tree harvest; transport of personnel/equipment/ material - land.

Impact: attraction to artificial food source.

Foreyt, W.S., and D.A. Jessup. 1982. Fatal pneumonia of bighorn sheep following association with domestic sheep. J. Wildl. Dis. 18(2): 163-168. (UAF)*

Bighorn sheep of all life stages were observed in 1978 and 1979 in central Washington State and in northern California in this field and lab research report. Both herds were confined in enclosures in western coniferous forest habitat. The activity of grazing was responsible for the documented direct impact of disease transmission from domesticated animals. The conclusive results were that nearly all bighorn sheep in both herds died, although they had been in excellent condition, from acute bacterial pneumonia shortly after contact with domestic sheep. In one case, domestic sheep were enclosed with bighorns, and in the other a fence separated them. The domestic sheep were unaffected and apparently healthy. In one case, a veterinarian had previously determined that all of the domestic sheep were healthy. Although the presence of domestic sheep may have been an important stress that initiated or compounded the disease, strong circumstantial evidence indicates transmission of pathogenic bacteria. Literature suggesting mortality from introduced diseases as the most important factor in the dramatic population declines of bighorn sheep in North America in the last few decades is also discussed. The authors recommend that bighorn and domestic sheep not occupy the same ranges or be managed in close proximity to each other because of the potential adverse effect on the bighorn sheep.

Although conditions uner which the study was conducted are not comparable to those existing in Alaska, the susceptibility of bighorns to disease is similar to that of Dall sheep. The latter, however, have not yet been exposed to domestic sheep, and no literature on the subject exists.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Geist, V. 1971a. A behavioral approach to the management of wild ungulates. Pages 413-424 in E. Duffey and A.S. Watt, eds. The scientific management of plant and animal communities for conservation. Eleventh symposeum of the British Ecological Society. Blackwell Sci. Publ., Oxford, England. (ADF&G-F)*

In this review paper, the behavioral characteristics of wild ungulates including moose, Sitka black-tailed deer, mule deer (closely related to Sitka black-tailed deer), bighorn sheep (similar in behavior to Dall sheep), caribou, and reindeer (closely related to caribou), in various habitat types throughout the world, including arctic and subarctic areas, are discussed in relation to human disturbance. The original studies were made over the past three decades. The following activities are discussed: clearing, drilling, grading/plowing, human disturbance, and transporting personnel/equipment/-material by land and air. The results describing the direct impacts listed below are conclusive. Bighorn sheep are attracted to artificial food sources (stands of planted grasses) along highway embankments and ski runs and are killed by collisions with vehicles. Impassable barriers to movement of ungulates (species not specified) are created by snow ploughed off roads. Where several ungulate species coexist, significant changes in habitat preference by one species due to harassment may lead the "introduced" wild ungulate into competition with other wild ungulates, causing loss of other species. A change in harvest level (prolonged and extensive hunting) potentially will alter species biology to smaller, shorter-lived, more secretive forms of a species. Active and passive harassment has several detrimental effects, including increased susceptibility to predation and parasitism (lethal diseases in reindeer), mortality from emphysema (reindeer), running injury and calf trampling (reindeer), interference with weight gain and nutrition required for reproductive behavior (reindeer), and voluntary withdrawal from available habitat and confinement of the population to a smaller and maybe less favorable area. Returning to favorable habitat is most difficult and the effects of disturbance most severe for non-nomadic social species such as mountain sheep, and easiest for nongregarious ungulates (e.g., moose and deer) and nomadic social species (e.g., caribou). Recommendations are that habitat conservation alone will not assure success in maintaining populations of ungulates, particularly of social species. The fact that human contact results in learning (usually to the benefit of neither the ungulates nor man) must be employed constructively; steps may have to be taken to educate both visitors and ungulates in areas where visitors are common and to modify visitor behavior so as not to alienate the ungulates.

Activity: clearing and tree harvest; drilling; grading/plowing; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from.

Geist, V. 1975. On the management of mountain sheep: theoretical considerations. Pages 77-105 in J.B. Trefethen, ed. The wild sheep in modern North America. New York: Winchester Press. 302 pp. (ADF&G-W, Heimer)*

In this review and discussion article, Dall sheep of all life stages throughout their range in Alaska and the mountains of northwestern Canada, as well as stone and bighorn sheep in North America, are considered in relation to human impacts and management. Habitat types for Dall sheep include alpine tundra and open subalpine forests; for other sheep, subalpine grasslands are also included. The activities of human disturbance and processing of minerals are responsible for the direct, documented impacts of active and passive harassment. The increased energy demands due to harassment of ungulates, strictly limited in food intake, directly result in decreased fetus growth, milk production, or longevity. Sheep can be habituated to human activities other than hunting, but, especially when combined with other disturbance, hunting can result in abandonment of high-quality range, confinement to safe escape terrain, and local extinction. Mitigation recommendations related to disturbance include 1) habituating sheep to activities other than hunting, by informing people of appropriate behavior and teaching sheep if necessary; and 2) for hunted populations, limiting the amount of other human contact, as hunted sheep generalize from hunters to other humans and learn to flee anyone.

Activity: grading/plowing; human disturbance; processing minerals (including gravel).

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Goodson, N.J. 1982. Effects of domestic sheep grazing on bighorn sheep populations: a review. Bienn. Symp. North. Wild Sheep and Goat Council. 3:287-323. (ADF&G-F, W. Heimer)*

In this review article, the effects of grazing domestic sheep on bighorn sheep populations of all life stages throughout the historic and current range of bighorn sheep in the Rocky Mountains of the United States and southern Canada are discussed. Articles cited were written between 1938 and 1982 and include studies done at all seasons of the year. Bighorn sheep are closely related to Dall sheep, and the latter are expected to be susceptible to the same impacts of grazing of domestic sheep. Although the study areas are south of Alaska, habitat types are for the most part comparable because of mountainous, high-elevation terrain and continental climate, and include mixed coniferous-aspen forests, open subalpine coniferous forest, meadows, shrub stands, alpine tundra, and talis slopes and cliffs. The activity of grazing was responsible for the documented direct impacts of competition with domestic sheep for forage and for space (social intolerance), disease transmission, and active and passive harassment by herders and dogs. The activity of plowing and growing hay was responsible for the documented direct impact of attraction to hay and subsequent death from rumen compaction. Current bighorn populations in the western United States are estimated to be 1% of presettlement numbers in the early 1800's. Introductions of domestic sheep onto bighorn ranges in the late 1800's were followed by massive die-offs from scabies, contracted from domestic sheep. Competition for forage and space was also important. Since 1940, severe declines or die-offs in seven free-ranging and two captive remnant bighorn populations in the United States and Canada have been reported following introduction of domestic sheep onto bighorn ranges. The bighorn populations had been stable or expanding but died off within a few months because of bacterial pneumonia contracted from domestic sheep. Chronic sinusitis, introduced from domestic sheep, causes morbidity over a period of a few years, ending in early mortality. It is a major cause of low vigor and death in desert bighorn populations. In addition to declines after association with domestic sheep, eight bighorn herds have increased significantly following reduction or removal of domestic sheep from their ranges. Removal of domestic sheep removes direct forage competition, habitat restriction through social avoidance, and lowered resistence to infection or parasitism (e.g., by lungworms) from stress caused by crowding, poor nutrition, and harassment by herders and their dogs. Management recommendations are the following: 1) prevent contact between domestic sheep and bighorns, 2) do not introduce domestic sheep onto occupied bighorn range nor convert cattle grazing leases to sheep on bighorn range; 3) reduce or eliminate current grazing of domestic sheep on bighorn ranges; and 4) maintain a minimum buffer distance of 3.2 km (2 mi) between occupied bighorn range and areas in which domestic sheep are grazed.

[Reviewer's note: This is an excellent review of the historical and modern documented effects of livestock grazing on mountain sheep. It is thorough and includes a wealth of well-documented recent impacts, many by pers. comm.

and not found elsewhere in the literature. The literature cited section is extensive if more detail is needed.]

Activity: grading/plowing; grazing.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from.

Graf, W. 1980. Habitat protection and improvement. Pages 310-319 in G. Monson and L. Sumner, eds. The desert bighorn: its life history, ecology and management. Tucson: Univ. Arizona Press. 370 pp. (HD)*

This brief discussion article suggests mitigative measures for impacts on desert bighorn sheep of all life stages throughout their range in the southwest United States desert mountains. Although the habitat types are not directly comparable to Dall sheep habitat in Alaska, several types of impacts that have not yet occurred to Dall sheep are discussed, and bighorn sheep responses are expected to be similar to those of Dall sheep. The activities of blasting, fencing, grading, human disturbance, transport of water by land, transporting personnel/equipment/material by land, and water regulation are discussed in relation to the direct impacts (not documented in detail, as that was not the intent of the article) of barriers to movement, active and passive harassment, harvest increase (poaching), and indirect impacts of terrain alteration or destruction and vegetation damage or destruction due to mechanical removal or material overlay. Specific mitigation guidelines include the following: 1) water sources (analogous to mineral licks) must be neither disturbed nor usurped by mining, and habitat destruction due to mining minimized; 2) no camping within 0.4 km (0.25 mi) of a water source, routing of trails away from critical areas, and limitations on human and vehicle use; 3) see Helvie 1971 for recommendations on fence construction; 4) follow the size recommendations in this article for transportation undercrossings, which must be located on known bighorn routes; and 5) segregate habitat as a solid block of land against all forms of land disposal.

Activity: blasting; fencing; grading/plowing; human disturbance; transport of oil/gas/water - land; transport of personnel/equipment/material - land; water regulation/withdrawal/irrigation.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to hydraulic or thermal erosion, etc.

Graham, H. 1971. Environmental analysis procedures for bighorn in the San Gabriel Mountains. Trans. Desert Bighorn Counc. 15:38-45. (UAF)*

In this field research paper dealing with the same study as Light (1971), desert bighorns of all life stages were studied during a 12-month period in 1970 and 1971 on Mt. San Antonio in the San Gabriel Mountains of southern California at elevations from 762 to 3,049 m (2,500 to 10,000 ft). Although the habitat types of coniferous forest, chaparral, open subalpine forests and herbaceous alpine barrens are not comparable to those used by Dall sheep, the use of separate winter and summer ranges and the responses of bighorn sheep to human disturbance are similar to those of Dall sheep. The activity of human disturbance was responsible for the documented direct impact of passive harassment. Conclusive results of a comparison of maps of human summer use areas, current and historic sheep summer use areas, and habitat quality for sheep showed that bighorn avoid historic summer range with 500 to 900 visitor-days of human use. Less than 100 visitor-days of use caused no decrease in bighorn use, and 100 to 500 visitor-days had little determinable effect.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Graham, H. 1980. The impact of modern man. Pages 288-309 in G. Monson and L. Sumner, eds. The desert bighorn: its life history, ecology and management. Tucson: Univ. Arizona Press. 370 pp. (HD)*

This article reviews and discusses impacts of modern man on desert bighorns of all life stages throughout their range in the southwest United States from the period of early Spanish explorers to the present. Although the habitat types used by bighorns are analogous to those of Dall sheep only in having rocky escape areas and lacking trees, bighorns have been subjected to impacts not yet faced by Dall sheep, and their behavior is expected to be similar. The activities of fencing, grazing, human disturbance, sewage disposal, transport of water by land, transporting personnel/equipment/material by air and land, and water regulation are responsible for documented direct impacts of barriers to movement, collision with vehicles, competition with introduced domestic animals, entanglement in terrestrial structures, entrapment in excavations or impoundments, and active and passive harassment; and indirect effects of vegetation damage or destruction due to grazing by domestic animals, and water level fluctuations. In addition, the activities of transport by land and air and processing of materials, among others, are responsible for the potential indirect impact of vegetation damage or destruction due to air pollution. Conclusive results concerning impacts not yet affecting Dall sheep but possible in the future include the following: 1) disturbance of lambing cliffs (and certainly permanent human occupancy nearby) (no distance stated) will cause abandonment; 2) frequent disturbance of bedding areas will cause abandonment; 3) five-strand barbed wire fences entangle and kill sheep, especially rams; 4) aqueducts with steep concrete sides and impoundments greater than 0.2 km (0.125 mi) wide drown sheep; and 5) unfenced multilane freeways, but not smaller paved roads, act as partial barriers, and all high-speed highways result in minor collision losses. Mitigative guidelines related to the above results include: 1) use of hog wire rather than barbed wire for highway fencing; 2) provision of underpasses, large culverts, or use of tunnels to provide for movement across highways; and 3) human habitation should not be allowed within one-half mile of water sources (analogous to mineral licks for Dall sheep).

Activity: channelizing waterways; fencing; grazing; human disturbance; sewage disposal; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; water regulation/withdrawal/irrigation.

Impact: barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; entanglement in fishing nets, marine or terrestrial debris, or structures; entrapment in impoundments or excavations; harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to grazing by domestic or introduced animals.

Hansen, C.G. 1971. Overpopulation as a factor in reducing desert bighorn populations. Desert Bighorn Council Trans. 15:46-52. (UAF)

In this brief review and discussion article, the effects of a variety of human development projects on bighorn sheep of all life stages in the deserts and mountains of the southwest United States are described. The papers on which this review is based were published between 1953 and 1970 and include studies done during all seasons of the year. Bighorn sheep are closely related to Dall sheep and behave similarly in response to man's activities. Although the latitude of the study area is considerably south of Alaska and the habitat types of mixed coniferous forests, subalpine meadows, and cliffs are similar to those in Alaska only in their open appearance, the impacts of developments on sheep are expected to be the same. Documentation of the impacts of most of the activities discussed in this article is not available for Dall sheep because the activities have not yet occurred extensively in Dall sheep habitat. The following activities were responsible for the corresponding documented direct or indirect impacts: fencing resulted in barriers and entanglement; grading of land for residential subdivisions resulted in vegetation destruction; grazing of domestic sheep and cattle resulted in competition for forage and space, increased predation because of crowding of bighorns into areas free from livestock and an increase in predators feeding on livestock, vegetation damage due to grazing by livestock, and loss of water for bighorn use because of consumption and pollution by livestock; human disturbance resulted in harassment; new roads caused an increase in poaching; and wide high-speed highways created barriers and resulted in deaths from collisions with vehicles. Results of the cited studies were conclusive. Bighorn populations even in areas with adequate food and water are decreasing as a result of overcrowding, stress, and associated spread of diseases because of human disturbance and loss of habitat. Population density in bighorn habitat is limited by social mechanisms, not directly by food or water. Mitigation suggestions are to provide remaining bighorn herds with habitat that includes the following: adequate forage, adequate escape terrain, free egress and ingress for adequate gene flow with adjacent herds, and sufficient space to maintain adequate social behavior patterns where stress is not a limiting factor.

Activity: fencing; grading/plowing; grazing; human disturbance; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; entanglement in fishing nets, marine or terrestrial debris, or structures; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; parasitism and predation, increased susceptibility to; vegetation damage/destruction due to grazing by domestic or introduced animals; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Heimer, W.E. 1978. Big game investigations: Dall sheep responses to human activity. ADF&G. Final rept. (research). Proj. W-110, Job 6.13R (ADF&G-F)*

In the field research described in this paper, population trends, lamb production and survival in two low-quality populations of Dall sheep in alpine tundra habitat in the Alaska Range - the Denali National Park population subject only to viewing by humans and the Dry Creek population subject to disturbance by several human activities - were studied from 1974 through 1979. The activities of human disturbance and transport of personnel/equipment/material by air and land were considered as potentially resulting in the direct impact of harassment. Conclusive results were that regulated hunting (older rams only), limited research activities including sampling of animals, regulated intensive mineral exploration, frequent traffic by light fixed-wing aircraft, and some helicopter traffic (no altitude stated for aircraft traffic), had no deleterious effects on lamb production, survival to yearling age, and population trend. Recommendations are that although Dall sheep do not need to be excessively protected from all human activities, activities that occur in Dall sheep habitat should be rigidly monitored and limited in time and scope. Harassment levels during this study were seasonal and generally of short duration.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Helvie, J.B. 1971. Bighorns and fences. Desert Bighorn Council Trans. 15:53-62. (UAF)*

In this field research report, the effects of different types of fences on bighorn sheep of all life stages were tested on the Desert National Wildlife Range, Nevada, between September 1970 and January 1971. Bighorn sheep are similar to Dall sheep in behavior and in body size. Although the study area is located considerably south of Alaska and the habitat types of cool temperate deserts, open coniferous forests, and meadows are comparable to those in Alaska only in the openness of the habitats, the effects of fences are expected to be similar in Alaska. The activity of fencing was responsible for the documented direct impacts of barriers to movement and of entanglement and death. Conclusive results showed that bighorns of all ages and both sexes become entangled in barbed wire and woven wire fences and are killed, although three- to five-year-old rams are caught most frequently. The following recommendations are made for fence designs that will hold cattle but allow bighorn sheep to pass through without entanglement.

Barbed wire fence

1. Posts should be placed not further than 3 m (10 ft) apart, to maintain proper spacing of wires.
2. Wires should be spaced 51, 89, and 99 cm (20, 35, and 39 in) above the ground; if needed, a fourth wire may be spaced 109 cm (43 in) above the ground.
3. The bottom wire should be smooth, not barbed, because sheep will usually go through the fence beneath this wire.
4. The spacing between the top two (or three) wires should never exceed 10 cm (4 in), or sheep can stick their heads through and be slashed or hanged.
5. The space between the lower two wires should never be less than 38 cm (15 in), or sheep may be caught and hanged.

Rail fence

1. Posts should be placed not further than 3 m (10 ft) apart.
2. Rails should be made from 5 cm (2 in) diameter steel pipe or 10 cm (4 in) diameter wood poles, because rams can easily break 5 cm (2 in) wood rails.
3. The lower edges of the rails should be spaced 51, 97, and 118 cm (20, 38, and 44 in) above the ground.

Other fences

1. If a woven wire fence is necessary, use only a mesh size of 5 by 10 cm (2 by 4 in) or smaller.
2. If an exclosure is necessary to stop cattle while allowing sheep within it, it should be large (e.g., 30 x 30 m, 100 x 100 ft) to reduce the feeling of confinement.

3. If a fence is needed only to prevent vehicle access, use a single cable or rail to allow safe travel by wildlife.

[Reviewer's note: These specifications apply to bighorn sheep and are not necessarily directly applicable to Dall sheep.]

Activity: fencing.

Impact: barriers to movement, physical and behavioral; entanglement in fishing nets, marine or terrestrial debris, or structures.

Hicks, L.L., and J.M. Elder. 1979. Human disturbance of Sierra Nevada bighorn sheep. J. Wildl. Manage. 43(4):909-915. (UAF)*

California bighorn sheep in all life stages were studied in the Sierra Nevada Mountains of California from May through August 1976 in this report of field research. Bighorn sheep are similar in behavior to Dall sheep, and although the forage plants are of different species, the overall physical appearance of alpine tundra habitat and subalpine open forests in the Sierra Nevada summer range are similar to comparable habitats in Alaska, in terms of cover and sight distances. The activity of human disturbance was hypothesized to result in the potential direct impact of barriers to movement (human trails). The activity of human disturbance resulted in the documented direct impacts of passive and active harassment. Conclusive results were that the current regulated use of the Bighorn Zoological Area by backpackers does not interfere with bighorns. Only campsite areas are not used by bighorns; human trails are not avoided. Sheep use of meadows is proportional to forage quality, not inversely proportional to human use. When approached, groups of ewes, lambs, and yearlings reacted more strongly than groups of rams; smaller groups reacted more strongly than larger ones; and approach from above elicited a stronger reaction than approach from below. Sheep continued to use a mineral lick near (distance not stated) a trail where hikers could be seen approaching from below at a distance. Management recommendations are to continue current regulations, with increased restrictions on off-trail hiking and alteration of the major trail past the mineral lick to route people away from areas intensely used by sheep.

Activity: grading/plowing; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Hoefs, M., and V.C. Brink. 1978. Forage production and utilization of a Dall sheep winter range, southwest Yukon Territory. Pages 87-105 in D.M. Hebert and M. Nation, eds. Proceedings of the biennial symposium of the northern wild sheep and goat council, Penticton, British Columbia, 11-14 April. (HD)*

In this field research report, winter range habitat of Dall sheep of all ages and both sexes on Sheep Mountain, Kluane National Park, southwest Yukon Territory, was studied during the growing seasons of 1969, 1970, and 1971, and during the last week of April of 1970 and 1971. The habitat types of alpine tundra and exposed, windblown ridges in subalpine and boreal forest zones are very similar to those used by sheep in Alaska. The activity of grazing of horses on Dall sheep winter range is responsible for the indirect impact of competition with introduced domestic species and vegetation damage or destruction due to grazing. Conclusive results of vegetation sampling using exclosures for Dall sheep and for horses showed that sheep alone utilize vegetation production on winter range to the maximum allowable degree (50%) in some years and are depressing vegetation production in some sites. Winter forage production was highly correlated with sheep yearling survival and lamb production during the years of this study. The recent introduction of horses results in overutilization of certain sites in certain years and will eventually result in a decrease of the sheep population. The author strongly implies that grazing of horses on sheep winter range should be discontinued.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to grazing by domestic or introduced animals.

Horejsi, B. 1976. Some thoughts and observations on harassment and bighorn sheep. Pages 149-155 in Proceedings of the Biennial Symposium of the northern wild sheep council, Jackson, WY, Feb. 10-12. (ADF&G-F)*

Both Dall and bighorn sheep are discussed in this informal review article, which also draws upon observations of Dall sheep in British Columbia by the author. Inasmuch as the author does not distinguish among the three sheep species found in British Columbia in some examples, it is assumed that the response of the three wild sheep species to disturbance is similar. Sheep habitat in the mountains of British Columbia including alpine tundra and subalpine open forest is similar to that in Alaska with respect to differentiation of winter and summer ranges, escape and feeding areas, and other aspects important to harassment. Observations were made over several years, the earliest reported in 1971. Activities responsible for the impacts are human disturbance and transporting personnel/equipment/material by air and by land. All impacts discussed are direct. Documented impacts include barriers to movement and active and passive harassment. Increased susceptibility to predation is strongly implicated for sheep but documented by a reference only for white-footed mice.

Active harassment by people on foot, as well as by aircraft, conclusively results in stronger flight response by sheep than that due to natural predators such as wolves. The former often enter escape terrain and continue to pursue sheep, unlike the latter. Sheep were regularly observed to scatter and run to exhaustion from the sound of a helicopter one mile away. In areas where sheep have been hunted, all humans are feared. This response may persist in the population for generations, as documented for red deer and chamois in New Zealand. Responses of individually marked sheep to humans were observed to be stronger when they were on summer than on winter range, because of a higher frequency of unpredictable encounters on the summer range.

Passive harassment of sheep was observed to be less severe when people and vehicles followed a predictable pattern (staying on a road). Even then, if a disturbance is frequent, severe, and cannot be avoided, wild sheep may not run but are potentially subject to psychological stress resulting in reduced growth rates, social dysfunction, and death of lambs, as documented for domestic sheep. It is emphasized that wintering and lambing areas must be protected from all forms of human harassment.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Howe, D.L., G.T. Woods, and G. Marquis. 1966. Infection of bighorn sheep (Ovis canadenisis) with Myxovirus parainfluenza-3 and other respiratory viruses. Results of serologic tests and culture of nasal swabs and lung tissue. Bull. Wildl. Dis. Assoc. 2(2):34-37. (UAF)

Bighorn sheep of all life stages in Wyoming and western Montana were sampled for antibodies to respiratory viruses in an unstated year and season for this field and lab research report and discussion. Although the habitat types are not directly comparable to Alaska, Dall sheep have not yet been exposed to most livestock diseases so references are not available, and they are expected to be as susceptible as bighorns. The activity of grazing of domestic livestock in the Rocky Mountain region in the late 1800's was apparently the cause of the direct, documented impact of disease transmission to previously abundant bighorn herds resulting (along with other factors) in their reduction to a few scattered groups, in which the diseases persist to the present. In this study, the presence of bovine myxovirus parainfluenza-3 in bighorn sheep was conclusively proven and its role in a lethal epizootic strongly implicated.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Jakimchuk, R.D., D.J. Vernam, and L.G. Sopuck. 1984. The relationship between Dall sheep and the Trans-Alaska pipeline in the northern Brooks Range. Renewable Resources Consulting Services Ltd. Sidney, B.C. March. xii + 156 pp. (ADF&G-F)*

In this field research report, Dall sheep of all ages and both sexes in the northern Brooks Range along the Trans-Alaska Pipeline System (TAPS) right-of-way (ROW) were studied from May through October in the years 1981 through 1983. Habitat types included arctic and alpine tundra associations from tall shrubs along creeks to dry ridge mat and cushion tundra. The activities of human disturbance, transport of oil by land, and transporting personnel/equipment/material by air and land were responsible for the documented direct impacts of attraction to artificial food source, collision with vehicles, active and passive harassment, and change in level of harvest. The following results are conclusive. In early winter, over 41% of sheep observed along the TAPS corridor were using revegetated areas instead of low shrub or mesic sedge-grass tundra. Sheep used man-made mineral licks at material sites and along the ROW. In 1982, five sheep were killed by collisions with vehicles on the road. Sheep were habituated to active and passive harassment by aircraft and trucks, 20% responding to helicopters at 200 to 500 m (656 to 1,640 ft) and to trucks at 200 m (656 ft). Stronger responses occurred to humans on foot, 90% responding at distances of 200 to 500 m (656 to 1,640 ft). Harvest levels increased to former levels after the TAPS corridor was reopened to big game hunting by bow and arrow. The pipe and road do not act as significant barriers to sheep, and lambing areas within 500 m to 1 km (0.3 to 0.6 mi) from the road and mineral licks a few meters from the road continue to be used. The population is stable at the preconstruction level. Recommendations are as follows: 1) future projects should use methods and mitigative measures similar to those employed in the construction and operation of TAPS; 2) monitor hunting take and retain the present harvest rate and closure to firearms; 3) monitor roadkills and apply mitigative measures if the mortality rate increases.

[Reviewers note: Results of this study contrast with those of Lindermann (1972) and Price and Lent (1972) prior to the habituation of sheep to human activities.]

Activity: grading/plowing; human disturbance; transport of oil/gas/water - land; transport of personnel/equipment/material air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Jorgensen, P. 1974. Vehicle use at a desert bighorn watering area. Trans. Desert Bighorn Counc. 18:18-24. (UAF)

During June 1973 bighorn sheep of all life stages were observed at the Middle Willows watering area, Coyote Canyon, Anza Borrego Desert State Park, southern California, as described in this field research paper. Although the habitat type of dense desert shrubs and small trees along a perennial stream between rocky ridges is unlike those utilized by Dall sheep in Alaska, the water source near escape terrain is an essential resource in a small area, comparable to mineral licks, and the response of sheep to human activity is expected to be similar. The activities of transport of personnel/equipment/material by land and human disturbance were responsible for documented, direct impacts of barriers to movement, and passive harassment. On days in which recreational vehicles passed through or stopped along the creek, bighorn use decreased roughly 50% throughout the day, with the greatest decrease in use by rams and the least by yearlings. Sheep ran from the watering area up the ridges at the approach of vehicles and would not cross the valley. A comparable watering area with an often-used foot trail along it is also used by sheep for feeding and bedding; the latter activities do not occur in the vehicle use area.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

This review article discusses the interactions between agriculture and wildlife, including bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the continguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level, and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine, during white settlement, are attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain-growing areas in Alaska, in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms, and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Krausman, P.R., and J.J. Hervert. 1983. Mountain sheep responses to aerial surveys. Wildl. Soc. Bull. 11(4):372-374. (UAF)*

This field research report discusses the effects of a small, low-flying, fixed-wing aircraft on bighorn sheep (Ovis canadensis mexicana) of all life stages in western Arizona between March 1980 and July 1982. Bighorn sheep are closely related to Dall sheep and behave similarly in response to disturbance. The habitat types of sparse coniferous woodland, subalpine open forest, and deserts are not directly comparable to those in Alaska, and the study area is south of Alaska, but the open characteristics of the habitat and long sight distances, important in disturbance studies, are comparable to those of Dall sheep habitat in Alaska. The activity of transporting personnel by air and making low passes over sheep for research purposes was responsible for the documented direct impact of active harassment. Conclusive results showed that sheep reacted extremely to overflights at less than 50 m (164 ft) above ground level (agl), moving more than 1 km (0.6 mi). Flights at 50-100 m (164-328 ft) agl caused extreme harassment in 2 of 15 cases, and flights at 100-400 m (328-1,312 ft) agl resulted in slight harassment (movement less than 100 m [328 ft] and continuation of predisturbance behavior) or no change from prior behavior. Mitigation guidelines recommended by the authors are to fly surveys at 50-100 m (164-328 ft) agl to reduce harassment of sheep and above 100 m (328 ft) to minimize harassment.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Lenarz, M. 1974. The reaction of Dall sheep to an FH-1100 helicopter. Chapter 3, pages 1-12, in R.D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser., Vol. 23. Prepared by Renewable Resources Consulting Services Ltd. for Canadian Arctic Gas Study Ltd. and Alaskan Arctic Gas Study Company. (UAF)*

In this field research article, the reactions of Dall sheep of all life stages to low-level overflights by a Fairchild-Hiller 1100 (FH 1100) helicopter during surveys conducted in April and early August 1973 in the Canning River drainage of the North Slope of Alaska were observed and analyzed. The habitat type was arctic tundra, including dry, wet, and riparian shrub areas as well as nonvegetated cliffs and talis cones. The documented direct impact was active harassment. Conclusive results were that sheep that had become habituated to heavy fixed-wing air traffic for 2 yr were obviously harassed by the FH-1100 helicopter flown within 91-152 m (300-500 ft). At that distance, 36% of 154 groups of sheep ran in panic, 49% walked slowly less than 91 m (100 yd), and 15% became alert or stood up if bedded but did not walk. Rams were less sensitive than ewes with or without lambs. Responses were independent of group size, April vs August time, and flights above vs below sheep.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Leslie, D.M. Jr., and C.L. Douglas. 1980. Human disturbance at water sources of desert bighorn sheep. Wildl. Soc. Bull. 8(4):284-290. (UAF)*

Desert bighorn sheep of all life stages in southern Nevada were tagged and their movements documented during the summers of 1973 through 1978, as discussed in this field research paper. Habitat types on the summer range were cresote bush and desert wash open-shrub communities. Although these habitats are not comparable to any in Alaska, water sources are essential point habitat components comparable to mineral licks used by Dall sheep in spring and early summer, and both alpine tundra and desert habitat types have little cover. All species of wild mountain sheep are similar in behavior. The activities of human disturbance and transport of water by land were responsible for documented direct impacts of attraction to an artificial food (water) source and passive harassment. All year-round water sources in the study area are artificial and allow summer use of what was previously winter range. Ram behavior patterns were not predictable enough to detect changes, but despite being habituated to human activity, ewes conclusively changed summer ranges to avoid increased construction activity at a water source, thereby displacing ewes previously using the new range. Displacement to lower quality range potentially decreases lamb recruitment or survival, but no such effect was detected. Bands of sheep not habituated to humans would be expected to show stronger responses. It is recommended that human use of water sources in areas inhabited by desert bighorn sheep be curtailed in favor of protecting these critical sites.

[Reviewers note: This is a well-done study.]

Activity: human disturbance; transport of oil/gas/water - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Light, J.T. 1971. An ecological view of bighorn habitat on Mt. San Antonio. Pages 150-157 in E. Decker, ed. Transactions of the first North American wild sheep conference, Colo. State Univ., April 14-15, 1971. Fort Collins, CO. 187 pp. (UAF)*

In this field research report, dealing with the same study as Graham (1971), desert bighorn sheep of all life stages were observed in relation to habitat and human recreation for a 12-month period in 1971 and 1972 in the entire 8 mi^2 range of the Mt. San Antonio herd. The habitat types of chaparral, coniferous forest, and alpine barrens are not comparable to habitats used by Alaskan Dall sheep, but behavior of bighorns with respect to human disturbance is expected to be similar. The activities of clearing and human disturbance were responsible for documented direct impacts of active and passive harassment. Conclusive results showed that heavy summer use of high value bighorn summer range (more than 500 visitor-days annually) excluded bighorn use. In individual encounters with humans, ewes with lambs retreated at greater than 91 m (100 yd), whereas individual ewes or rams allowed approaches to within 18 m (20 yd). Greater tolerance of Rocky Mountain bighorns toward human disturbance (e.g., Geist 1971) is explained by the occurrence of heavy stands of grass on escape terrain, unlike in southern California.

Activity: clearing and tree harvest; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Light, J.T. Jr. 1973. Analysis of bighorn habitat in the San Gabriel Mountains. Desert Bighorn Council Trans. 17:53-58. (UAF)*

In this field research report, the responses of bighorn sheep of all life stages to hikers in the Mt. San Antonio area of the San Gabriel Mountains, Southern California, were studied between 1970 and 1972 (also see Light 1970 and Graham 1972). Bighorn sheep are closely related to and behaviorally similar to Dall sheep. Although the geographic area is south of Alaska and the habitat types of open pine and fir subalpine forest, moist alpine meadows, and rocky areas are not the same as those in Dall sheep habitat in Alaska, terrain and sight distances that in part determine the degree of harassment that results from human disturbance are similar. Spring, summer, and fall hiking was responsible for the documented direct impact of harassment that led to range restriction. Conclusive results showed that bighorn rams tolerate humans on foot with a reaction of curiosity to a minimum distance of 110 m (120 yd), ewes to a minimum of 320 m (350 yd), and bighorns overall to an average minimum of 274 m (300 yd). Current human use of 500 to 900 visitor-days annually has caused bighorns to avoid historic, limited range. Range is limited by vegetation type, not water or terrain. The following mitigation guidelines are proposed:

1. All summer recreation travel routes should be at least 274 m (300 yd) and out of sight of bighorn concentration areas.
2. Public travel routes may be at least 137 m (150 yd) from and out of sight of ram concentration areas.
3. Cross-country travellers should be accompanied by a guide familiar with bighorn habitat and behavior. Such use should be discouraged during lambing seasons.
4. Summer recreation use of key bighorn range areas should not exceed 500 visitor days per year.
5. People should not be in groups larger than 10 on bighorn ranges.
6. Summer recreation developments should be discouraged on key bighorn ranges.
7. Construction of developments should be scheduled when bighorn are least likely to be in the area.
8. Areas of major human concentrations should not be allowed within 457 m (500 yd) nor within sight of key bighorn areas or travel routes.
9. Timber should be harvested during the winter months.
10. Key bighorn areas should be withdrawn from mineral entry.
11. Vehicle use on the study area should be confined to existing roads.
12. Helicopter observation of bighorns should be for scientific purposes only, on a designated flight plan, and not be conducted during the lambing season.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Linderman, S. 1972. A report on the sheep study at the Dietrich River headwaters. Appendix 3 in L. Nichols and W. Heimer, eds. Sheep report, Vol. 13. ADF&G, Juneau, AK. 11 pp. (ADF&G-F)*

Dall sheep distribution, movement patterns, productivity, and responses to low altitude aircraft were studied at the headwaters of the Dietrich River in the summer of 1971 and the results reported in this field research paper. Alpine tundra, subalpine white spruce woodland, and riparian habitats were examined. Transport of personnel/equipment/material by air was the activity responsible for documented direct impact of passive harassment. An average of more than four aircraft per day (two fixed-wing and two helicopters) passed over the study area, 75% low enough (no altitude stated) to evoke a conclusive response from sheep. Sheep responses were unpredictable, ranging from assuming an alarm posture to wildly running. Two mineral licks with well-defined trail systems indicating considerable past use were barely used in 1971. The author states that aircraft disturbance may have caused the abandonment of the licks and the summering area around them. Given that the oil pipeline will be routed along the Dietrich River (rather than through a wide, deep valley seldom used by sheep), the author makes these recommendations: 1) minimize construction activity during the May 15 to June 20 lambing and November 15 to December 30 rutting periods, with major construction from June 20 to November 15; 2) avoid disturbing mineral licks; 3) provide for sheep crossings of above-ground pipe at customary crossing areas; 4) require aircraft without specific low-level assignments to maintain minimum altitudes of 1,829 m (6,000 ft); and 5) the ADF&G should consider closing to hunting and off-road vehicle use a 9.6 to 16 km (6 to 10 mi) wide corridor along the upper Dietrich River.

[Reviewers note: The speculated abandonment of mineral licks is in conflict with observations of Fancy (1980) and Reynolds (1974).]

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

MacArthur, R.A., R.M. Johnston, and V. Geist. 1979. Factors influencing heart rate in free-ranging bighorn sheep: a physiological approach to the study of wildlife harassment. Can. J. Zool. 57:2,010-2,021. (UAF)*

In this field research project, the effects of various forms of harassment on heart rates of adult bighorn sheep ewes were studied between 15 March and 10 May of an unstated year in the Sheep River wildlife sanctuary, about 88 km (55 mi) southwest of Calgary, southern Alberta, Canada. Bighorn sheep are closely related to and behaviorally similar to Dall sheep, and the habitat types of subalpine mixed and coniferous forest and alpine tundra are also similar to those in Alaska. The activities of human disturbance (humans on foot) and passage of road vehicles and of a helicopter were responsible for the documented direct impacts of active and passive harassment. Heart rates usually increased while sheep were in attention postures before or in the absence of overt behavioral reactions. All sheep had been habituated to distrubance, and were free from hunting only inside the sanctuary. Free-ranging domestic dogs elicited the greatest heart rate increases when within 100 m (328 ft) of sheep, and humans on foot with or without a leashed dog caused responses within 50 m (164 ft). Responses were stronger when a dog was present. Responses occurred to passing vehicles on a gravel road within 200 m (656 ft). A helicopter 150-200 m (492-656 ft) overhead caused a dramatic response, but no response at 500-1,500 m (1,640-4,920 ft). The authors conclude that continuous exposure to humans within 50 m (164 ft) would result in a physiologically meaningful increase in energy cost but that transient disturbances would not.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

MacArthur, R.A., V. Geist, and R.M. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. J. Wildl. Manage. 46(2):351-358. (ADF&G-F)*

In this field research study of adult bighorn sheep on unhunted winter range in southwestern Alberta, from March through May 1978 and November through December 1979, telemetered heart rates and behavioral responses to human disturbance were analyzed. Bighorn sheep and Dall sheep are similar in behavior and use of habitat, and alpine tundra winter sheep range in Alberta is similar to that in Alaska. The activities of human disturbance and transport of personnel/equipment/material by land and air resulted in documented direct impacts of active and passive harassment. Conclusive results showed minimal heart rate and virtually no behavioral reactions of sheep to road traffic of all types at distances greater than 25 m (82 ft). At distances exceeding 400 m (1,312 ft), aircraft elicited no responses, but direct helicopter overflights at 90-250 m (295 to 820 ft) caused ewes to run for 2-15 seconds three of five times. Approach of sheep by a single human on foot from the road resulted in less sheep response than either approach over a ridge or approach with a leashed dog. Sheep had been habituated to predictable vehicular traffic and approach by humans from the road (often amateur photographers), but the presence of a canid (a traditional sheep predator) evoked a strong response. These data suggest that on sheep range used heavily for recreation, disturbance to sheep may be minimized by restricting human activities to roads and established trail systems. The presence of dogs on sheep range should be discouraged.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McCollough, S.A., A.Y. Cooperrider, and J.A. Bailey. 1980. Impact of cattle grazing on bighorn sheep habitat at Trickle Mountain, Colorado. Pages 42-59 in W.O. Hickey, chairman. Proceedings of the biennial symposium of the northern wild sheep and goat council, April 23-25. Salmon, ID. (ADF&G-F, W. Heimer)*

In this field research study, competition between domestic cattle and bighorn sheep of all life stages in the San Luis Valley of northcentral Colorado was examined throughout the year between May 1978 and October 1979. Bighorn sheep are closely related to Dall sheep and require similar habitats. Although the study area is south of Alaska and the drier habitat types of shortgrass and midgrass plains and meadows, shrub stands in draws, sparse to moderately dense coniferous forests at higher elevations, and cliffs are not directly comparable to alpine tundra in Alaska, competition for analogous types of forage is expected to occur in other habitat types in Alaska where cattle have not yet been grazed. The activity of cattle grazing was responsible for the documented direct impact of competition for forage. Winter-spring forage was assumed, based on bighorn ecology and physiology, to be limiting to the bighorn population. Conclusive results showed that during the summer cattle consumed 35% of the forage needed during winter and spring by bighorns. This occurred only at one site where water and productive meadows occur near bighorn escape terrain and lambing cliffs. Bighorn foraged within 240 m (787 ft) of escape terrain 90% of the time. In the study area overall, overlap in food habits of cattle and bighorn was moderate but overlap in geographic distribution minimal because cattle seldom used steep slopes (5° or more). The median slope angle for bighorn observations was 20 degrees. Cattle also remained near water: 50% of groups seen were within 240 m (787 ft) of water. The authors caution that a greater overlap in food habits and distributions could occur if either cattle or bighorn numbers were to increase. One management guideline is suggested to protect bighorns: water developments for cattle should be planned to be more than 1.5 km (0.94 mi) from critical winter-spring bighorn ranges, especially those having forage on level to moderate slopes.

[Reviewer's note: This is a very well-done study, based on statistically robust sampling and sound principles of competition between species.]

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

McCourt, K.H., J.D. Feist, D. Doll, and J.J. Russell. 1974. Disturbance studies of caribou and other mammals in the Yukon and Alaska, 1972. Arctic Gas, Biol. Rept. Ser. Vol. 5. Prepared by Renewable Resources Consulting Services, Ltd. for Canadian Arctic Gas Study Ltd, and Alaskan Arctic Gas Company. 246 pp. (UAF)*

In this field research report, the responses of Dall sheep rams, moose, and brown bears of all life stages to aircraft and other noise disturbances were studied. Dall sheep were studied in alpine tundra habitat in the northern Richardson Mountains of the Yukon Territory for two days in July 1972. Moose and brown bears were studied in the northern Yukon between March and October 1972. The latitude of the study area is the same as that of Alaska, and the habitat types of open boreal forest and arctic tundra are the same as those in Alaska.

Dall sheep. Dall sheep rams were experimentally subjected to the simulated sound of a gas pipeline compressor station and associated aircraft transportation. The activities of transporting oil/gas/water by land and transporting personnel/equipment/material by air were responsible for the direct, documented impact of passive harassment. Weather was similar throughout the control and test periods. During periods of compressor simulation, conclusive results were that most sheep abandoned summer range within 1.6 km (1 mi) of the simulator. Bedding and feeding patterns of those that remained were altered. Helicopter disturbance was more severe, causing all but one ram to leave the area until three hours after the helicopter disturbance. The possibility of habituation was not examined. The authors recommend that 1) sound attenuation measures be applied to any compressor stations located within 3.2 km (2 mi) of Dall sheep range; 2) by extrapolation, the location of borrow sites and the timing of construction in the vicinity of Dall sheep range will have to be carefully planned.

[Reviewer's note: These results are in apparent conflict with those of Reynolds (1974) but involved noncritical summer range rather than mineral licks. Weather problems in Reynold's study, discussed in the notes on that annotation, may also have affected the results.]

Moose. The activity of transporting personnel/equipment/material by air was responsible for the direct, documented impact of passive harassment. The reactions of moose to 46 incidences of aerial disturbance from fixed-winged aircraft were documented. Moose reacted 9 of 16 times to aircraft disturbance at elevations less than 61 m (200 ft) and 9 out of 24 times from aerial disturbance in the 61-to 183- m (200-to 600- ft) range. There were no reactions from 6 incidents of aerial disturbance from fixed-wing aircraft above 183 m (600 ft). A few observations on reactions of moose to helicopters indicate a similar insensitivity to rotary-winged aircraft. Mitigation recommendations are the following: 1) maintain a minimum altitude of 305 m (1000 ft) above ground level (agl) (including over ridges) for small fixed and rotary-winged aircraft in areas inhabited by caribou, moose, or brown bears; 2) practice rapid linear flight over animals, never unnecessarily circling or hovering over animals, especially over brown bears.

Brown bear. The activity of transporting personnel/equipment/material by air was responsible for the direct documented impact of passive harassment. Reactions of brown bears to overflights at altitudes of 0 to greater than 305 m (0 to greater than 1000 ft) agl were highly variable and independent of altitude, some animals responding strongly to flights over 305 m (1000 ft). Brown bears are much more sensitive to aircraft harassment than are caribou or moose. Mitigation recommendations include those for moose, and avoiding low level flights over areas with known grizzly concentrations.

Activity: transport of oil/gas/water - land; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McCrory, W.P. 1975. Study of ungulates along the proposed gas pipeline in British Columbia. Chapter 5, pages 1-49, in R.D. Jakimchuk, ed. Arctic Gas Biol. Rept. Ser. Vol. 32. Studies of large mammals along the proposed MacKenzie Valley gas pipeline route from Alaska to British Columbia. Prepared by Renewable Resources Consulting Services, Ltd. for Canadian Arctic Gas Study Ltd. and Alaskan Arctic Gas Study Co. (UAF)

In this field research report, bighorn sheep of all life stages were observed in the Elk River canyon, southeastern British Columbia, between October 1973 and December 1974 several times during the year, along the right-of-way (ROW) of an Alberta National Gas pipeline. Bighorn sheep are closely related to and behaviorally similar to Dall sheep. Although the study area is south of Alaska and the habitat type of Rocky Mountain coniferous forest with meadows and sage openings is drier than that in Alaska, responses of sheep to a pipeline ROW are expected to be similar. The activities of grading and revegetating the ROW and transporting gas by land were responsible for the documented direct impact of attraction to artificial food sources. Conclusive results were that sheep ate clay from an exposed cutbank, fed preferentially on lush green legumes that were growing only in the ROW in late November, and travelled and bedded down on the ROW.

Activity: grading/plowing; transport of oil/gas/water - land.

Impact: attraction to artificial food source.

McKendrick, J.D., C.L. Elliott, and C.P. Brody. 1984. Evaluation of plants used for stripmine reclamation near Healy, Alaska. Agroborealis 16(2): 3 + 5-8. June. (UAF)*

In this field research paper, artificial revegetation of stripmined habitat used by caribou and Dall sheep of all ages and both sexes near Healy, Alaska, was performed between 1972 and 1979 and evaluated in the summer of 1980-1981. Habitat types included open subalpine Boreal forest and alpine tundra vegetation. The activity of grading/plowing to mine coal resulted in the direct documented impacts of attraction to an artificial food source and vegetation damage/destruction due to mechanical removal or material overlay. Areas of the Usibelli mine from which coal has been extracted are recontoured, fertilized and seeded with a mixture of native and introduced grasses and legumes. Conclusive results showed that only three grasses consistently developed vigorous, persistent stands: red fescue (Festuca rubra) and bluejoint reedgrass (Calamagrostis canadensis) (both native), and smooth brome (Bromus inermis) (introduced). Legumes have not successfully established. Red fescue retains vigor when cut frequently and may tolerate wildlife grazing. Recommendations are as follows: 1) carefully examine seed lots to avoid introducing noxious weeds; 2) to establish persistent grass stands, use the above species; 3) as other native plants such as shrubs and forbs become available or for sites where eventual dominance by plants other than grasses is desired plant less persistent grasses.

Activity: grading/plowing.

Impact: attraction to artificial food source; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Millar, N. 1983. [Letter to Alaska Department of Fish and Game describing results of questionnaire, February 1983.] (HD)#*

This questionnaire dealt with the impact that different road standards have on wildlife.

Impacts on wildlife movement and habitat were believed to increase with higher road classes:

1) Class 1 roads (4-lane paved) were considered very restrictive to movement and very high in losses of habitat use. However, densities of class 1 roads were less than 0.1 km per square km (0.16 mi/mi^2) of area.
2) Class 2 (2-lane paved) and class 3 (2-lane gravel) roads were thought to restrict some movement and to reduce some habitat use. The densities of class 2 and 3 roads were 1.0 km per square km (1.6 mi/mi^2) of each area or less.
3) Class 4 (1-lane gravel or dirt) and class 5 (primitive track) roads were thought to have little influence on movement and little loss in habitat use. The densities of these roads were 2.6 km per square km (4.2 mi/mi^2) or less.

The greatest number of kills per km (mi) were reported on class 1 or 2 roads. There were no reported kills on class 5 roads.

Trends show design speed of greater than 64 kph (40 mph) and surface width of greater than 10 m (33 ft) contributed to mule deer mortality in forestry areas.

Wide clearing widths (exact width not stated) were thought to contribute to mule deer, white-tailed deer, sheep, and elk mortality.

Activity: clearing and tree harvest; grading/plowing; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc.

Nette, T., D. Burles, and M. Hoefs. 1984. Observations of Golden Eagle, Aquila chrysaetos, predation on Dall sheep, Ovis dalli dalli, lambs. Can. Field-Nat. 98(2):252-254. (UAF)*

In this field research report, Dall sheep ewes and lambs were observed between 23 June and 6 July 1982 in Kluane National Park, Yukon Territory, Canada. The latitude of the study area is that of Alaska, and the habitat types of alpine tundra on ridges and precipitous lambing cliffs are very similar to those in Alaska. The activity of transporting personnel/equipment/material by air was responsible for the documented direct impact of active harassment. During two helicopter surveys of ewe bands with lambs, sheep ran (once at a reported distance of 800 m, 2,624 ft), and in both cases a lamb running 2 to 8 m (6.6-26 ft) behind its mother was killed by a golden eagle that had been watching the band. Populations of alternate prey for eagles (willow ptarmigan, snowshoe hares, or small mammals) were very scarce at that time. Eagle predation had not been seen during seven previous years of sheep surveys by helicopter.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Nichols, L., and W. Heimer. 1972. Sheep report: productivity in unhunted and heavily exploited Dall sheep populations. ADF&G. Fed. Aid in Wildl. Rest. Proj. progress rept. Vol. 13. Projs. W-17-3 and W-17-4, Job 6.4R. Juneau. September. (ADF&G-F)*

In this field research study, Dall sheep were observed in alpine tundra habitat in the vicinity of Cooper Landing on the Kenai Peninsula throughout the year of 1971. The activity of transporting personnel/equipment/material by air for sheep composition counts was responsible for the impact of active harassment. In order to count very young lambs, ewes were forced to move by low passes (altitude not stated) of a fixed-wing aircraft. Some sheep, usually yearlings and lambless ewes, became excited over the close approach of the plane. Most, however, paid little attention or moved casually away. The frequent harassment did not cause an observable number of sheep to abandon their range. It is possible that the frequent close counting had some effect through harassment, on lamb survival.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Packard, F.M. 1946. An ecological study of the bighorn sheep in Rocky Mountain National Park, Colorado. J. Mammal. 27:3-28. (UAF)*

In this field research report and historical review article, bighorn sheep of all life stages were studied in Rocky Mountain National Park and in the surrounding area of northcentral Colorado between March 1939 and November 1940. Bighorn sheep are closely related to Dall sheep and have been subjected to a greater variety and intensity of human activities than have Dall sheep. Habitat types range from ponderosa pine forest at low elevations (winter range for some sheep), through mixed aspen-coniferous forests to subalpine coniferous forests and alpine tundra. The latter type is the most important for sheep as summer or year-round range and is directly comparable to Dall sheep range in Alaska. Activities responsible for the initial, severe decline in bighorn sheep populations occurred between about 1860 and 1906. Upgrading of a hard-to-find trail to the area of the park into a road about 1860 greatly increased market and ruthless sport hunting of sheep. Winter range and use of low elevation mineral licks was restricted by fencing, grazing, and grading/plowing and human disturbance associated with settlement and road construction. Grazing of domestic sheep was the extremely likely cause of the introduction of scabies, which decimated bighorns as early as 1878, and peaked in 1902. After a moderate recovery between 1909 and 1921, two factors were responsible for a second decline. Grazing of domestic sheep caused long-term damage to bighorn winter range, starving bighorns, and lack of availability of sedimentary mineral licks in lowland areas resulted in decreased parasite resistance, lung worm damage, and death from bacterial pneumonia. Mitigation recommendations are to place mineral salt blocks on the available mineral-poor granitic upland ranges.

Activity: fencing; grading/plowing; grazing; human disturbance; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from; parasitism and predation, increased susceptibility to; vegetation damage/destruction due to grazing by domestic or introduced animals; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Pendergast, B., L. Horstman, and L.R. Dorey. 1974. Population surveys of ungulates. Chapter 4, pages 1-40 in R.D. Jakimchuk, ed. Surveys of mammals along the proposed gas pipeline in Alberta. Arctic Gas Biol. Rept. Ser. Vol. 25. Prepared by Renewable Resources Consulting Services, Ltd. for Canadian Arctic Gas Study Ltd. and Alaskan Arctic Gas Study Co. (UAF)*

In this field research report, the effects of seismic blasting on bighorn sheep of all life stages were observed in an area near Calgary, southern Alberta, Canada, during late February and March 1974. Bighorn sheep are closely related to and behaviorally similar to Dall sheep. Although the study area is located south of Alaska and the habitat type of subalpine coniferous forest, meadows, and sagebrush areas is drier than that in Alaska, the responses of sheep to blasting are expected to be similar. Sheep habitat has a similar open appearance in both the study area and Alaska. The activity of blasting for seismic exploration for oil was responsible for the documented direct impact of harassment. Conclusive results based on the location and age of old tracks and the current location of sheep were that the blasting caused sheep to be displaced a distance of 0.8 km (0.5 mi). The type of blasting done is not described in detail.

Activity: blasting.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Pitzman, M.S. 1970. Birth behavior and lamb survival in mountain sheep in Alaska. M.S. Thesis, Univ. Alaska, Fairbanks, AK. 116 pp. (UAF)

In this field research report, Dall sheep of all life stages but primarily ewes during and for a few days after giving birth were observed on Surprise Mountain on the Kenai Peninsula, Alaska, in July, August, and November 1966 and from May through early September 1967. The habitat types included alpine tundra and cliffs and open subalpine boreal forest. Flying low (no altitude stated) over ewe and lamb groups via Supercub fixed-wing aircraft for research purposes resulted in the documented direct impact of active harassment. A ewe was found dead of a fall soon after a set of flights had been conducted in the same location, flights that had caused some sheep to run in panic.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Post, G. 1971. The pneumonia complex in bighorn sheep. Pages 98-106 in E. Decker, ed. Transactions of the first North American wild sheep conference, Colo. State Univ., April 14-15. Fort Collins. 187 pp. (UAF)

In this short review paper, bighorn sheep of all life stages throughout their range in North America are discussed. Although habitat types used by bighorns are not directly comparable to those of Dall sheep, the latter have not yet been subjected to human activities to nearly the extent that the former have, and can be expected to respond similarly. The activity of grazing is discussed as having been responsible for the historically documented direct impacts of competition with domesticated animals, disease transmission from domestic sheep or other livestock, and vegetation damage or destruction due to grazing by domestic animals. Although all of these factors are discussed as having contributed to the catastrophic decline of bighorns around 1900, Post attributes the die-off to bacterial pneumonia. The original source of this disease cannot be traced with certainty but it is similar or identical to bacteria found in domesticated sheep and in other domesticated animals.

[Reviewer's note: Disagreeing with Post, Buechner (1960) agrees with the classical interpretation that scabies, contracted from domestic sheep, was the final cause of the die-off.]

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to grazing by domestic or introduced animals.

Preston, D.J. 1983b. The impacts of agriculture on wildlife. ADF&G, Fed. Aid in Wildl. Rest. Final rept. (Research) Projs. W-21-2 and W-22-1, Job 18.6R. Juneau. 143 pp. (ADF&G-F)*

In this review paper, the effects of agriculture on all life stages of a variety of wildlife species throughout North America are discussed. The following wildlife species and species groups featured in the Alaska Habitat Management Guide are included: swans, geese, ducks, several furbearers, brown bears, deer, moose, caribou, mountain goats, and Dall sheep. These species either occur in Alaska or are closely related to Alaskan species and are expected to respond similarly to agricultural activities. The 1,200 references cited range throughout the geographic areas and habitat types of North America. In most cases, the overall impacts of agriculture are independent of the specific location in which they were documented. The original studies were done throughout all seasons over the past several decades and were published primarily after 1970. Most of the impacts are discussed in terms of major wildlife species groups (e.g., birds, ungulates) and are not applicable to the species approach used in the AHMG. The few impacts identified as affecting moose, mountain sheep, and furbearers are summarized by species, followed by mitigation guidelines suggested for those impacts.

Moose. The activities of clearing and tree harvest and grading and plowing were responsible for the documented indirect impact of vegetation composition change, and the activity of grading and plowing was responsible for the documented direct impact of attraction to an artificial food source. Conclusive results were that 1,200-2,000 ha (3,000-4,000 ac) of good moose winter range were lost to the Delta agricultural project. Cultivated land is used less than other habitat types. Moose are attracted to gardens, especially in rural areas of Alaska. Mitigation recommendations are to protect crops by means of fencing designed to minimize entanglement of moose and by other nonlethal methods.

Sheep. The activity of grazing has been responsible for the documented direct impact of competition with or disease transmission from domestic species. Impacts were documented on bighorn sheep only, but effects on Dall sheep are expected to be similar. Livestock compete with bighorns for forage, and domestic sheep have transmitted three lethal diseases to bighorns: scabies mites, bluetongue virus (sampled for and found not to be present in Alaskan wildlife), and parainfluenza-3 virus (which causes pneumonia). The mitigation recommendation is to prohibit grazing livestock in or near (no distance stated) Dall sheep range.

Furbearers. The activities of grading and plowing and grazing were responsible for the documented direct impact of attraction to artificial food sources. The activity of fencing was responsible for the documented direct impact of barriers to movement and that of chemical application for the documented direct impact of mortality due to ingestion of chemicals. Squirrels are attracted to gardens, coyotes to domestic sheep, calves, and poultry, and wolves to sheep, calves and yearlings, and horses. Coyotes are

poisoned by chemical traps and by toxic collars on domestic sheep and are kept out of flocks of domestic sheep by deterrent, directing, or electric fences. Mitigation recommendations include restricting calving and lambing to easily monitored areas and disposing of livestock carcasses properly.

Deer. The activity of grading/plowing (growing crops) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. The activity of grazing was responsible for the documented direct impact of disease transmission from introduced domestic species. These impacts were documented on white-tailed and black-tailed deer, and effects on Sitka black-tailed deer are expected to be similar. Five strand high-tensile electric fencing successfully prevented deer that had been attracted to crops from entering fields or orchards and was not prohibitively expensive. Lethal epizootics of foot and mouth disease, bluetongue, and epizootic hemorrhagic disease have spread through deer populations in the contiguous 48 states after livestock transmitted the diseases to deer. Deer in Florida have also been infested by the cattle fever tick. In two documented cases, tens of thousands of deer were slaughtered to prevent reinfection of livestock. Recommendations are to actively implement existing disease regulations pertaining to importing livestock into Alaska and to monitor wildlife populations for exposure to livestock pathogens. Regulations require that imported livestock be free from disease.

Mountain goat. No impacts on mountain goats were documented in this paper.

An extensive subject index, including a taxonomic index to wildlife species, directs the reader to the references cited. Numerous other mitigation recommendations are made but are not directly supported by impacts documented on a stated wildlife species.

[Reviewer's note: This is an excellent, thorough review of the agricultural impact literature within and outside of Alaska. Not all references are applicable to Alaska, and impacts are not all documented in the sense used in the AHMG.]

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Price, R., and P.C. Lent. 1972. Effect of human disturbance on Dall sheep (final rept). Alaska Coop. Wildl. Res. Unit, Univ. Alaska, Fairbanks. Quarterly Report 23(3):23-38. (ADF&G-F)*

A field study of a Dall sheep population in the Atigun River Canyon of the central Brooks Range was carried out from May through August 1970 and from June through August 1971, with brief visits at other times. Preconstruction activities for the Trans-Alaska Pipeline System, primarily transport of personnel/equipment/material by air through the canyon in twin-engine fixed-wing aircraft and in helicopters, affected sheep in this area of arctic tundra, talus slopes, and cliffs. Documented impacts to sheep were active and passive harassment. Conclusive results included the following points. Helicopters generally fly closer to sheep, fly slower and are more noisy than fixed-wing aircraft and cause greater disturbances of sheep. Usually, disturbance to grazing sheep was mild (running 9 m [10 yd] or less) if a helicopter came no nearer than 183 m (200 yd), but in one instance a band began sustained running when a helicopter was 0.8-1.2 km (1/2-3/4 mi) away. Long runs up to 0.8-1.1 km (1/2-2/3 mi) over rough talus resulted from helicopter approaches closer than 183 m (200 yd). Active harassment of sheep for close-up aerial photography caused the greatest disturbance. Sheep at mineral licks were more easily disturbed, making long runs after passive human or aircraft harassment at about 457 m (500 yd). Tentatively, mortality to a ewe from a broken neck caused by a fall during running may have resulted from harassment. Mitigation guidelines are made. No on-the-ground activity should be permitted in the canyon between mid May through early July and again starting in early August. No ending date for the latter period is mentioned. Carefully regulated activities not adjacent to mineral licks and lambing areas may be possible in mid summer. Aircraft using the canyon should fly as high as possible directly above the river. If this cannot be done, flights should be as low as possible directly over the river, but sheep at one mineral lick 457 m (500 yd) from the river may be disturbed.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Reynolds, P.C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks in the Brooks Range, Alaska. Chapter 2 _in_ R.D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser., Vol. 23. 82 pp. August. (ADF&G-F)*

The response of Dall sheep at mineral licks and of red fox in alpine tundra habitat along the Marsh Fork of the Canning River, eastern Brooks Range, Alaska, to simulated compressor station noise was tested during late July and early August of 1972. This field research article summarizes the results. The activities of transporting oil/gas/water by land and transporting personnel/equipment/material by air were responsible for the direct, documented impact of passive harassment. Conclusive results of control and noise exposure test periods showed no change in use of either of two licks, 0.4 and 1.2 km (0.25 and 0.75 mi) from the simulator, by all ages and sexes of sheep. Sheep did spend less time in the part of each lick exposed to the highest sound levels. The weather was cold, with mixed snow and rain, during the control periods and sunny and 20°F warmer during the noise simulation period. The author accounts for the apparent contradiction between these results and those of McCourt et al. (1974) as being due to two factors: 1) preconditioning in this study only by an average of three fixed-wing or helicopter flights daily along the river for the previous two months; and 2) mineral licks are a point resource presumably fulfilling a physiological need, while summer range (in McCourt et al.) is more widely distributed. Reactions to aircraft were also noted in Reynolds' study, with the conclusive result that sheep showed strong reactions (running) to helicopters within 137 m (150 yd) but little or no reaction to aircraft 0.4-1.2 km (0.25-0.75 mi). Caution is recommended in selecting compressor station sites due to the possible compounding impacts of the variety of activities associated with such facilities and not examined in this study.

A red fox den containing four pups located 1.6 km (1 mi) from the simulator remained occupied, but the foxes did not hunt between the den and the simulator during the experimental phase. The importance of acute hearing for hunting is cited as a cause of this passive harassment.

[Reviewer's note: Although the author does not consider the weather difference important, sheep use of licks is higher during good weather, and weather probably confounded the experimental results.]

Activity: transport of oil/gas/water - land; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Riggs, R.A., and J.M. Peek. 1980. Mountain sheep habitat-use patterns related to post-fire succession. J. Wildl. Manage. 44(4):933-938. (UAF)

The effects of natural fires on bighorn sheep of all life stages and their habitat in Glacier National Park, northern Montana, were studied between November 1976 and April 1977 and are described in this field research report. Bighorn sheep are closely related to Dall sheep and have similar habitat requirements. Although the study area is located south of Alaska, the high elevation and continental climate result in similar habitats of subalpine mixed coniferous and aspen open forests, bunchgrass meadows, and rock outcrops and scree slopes. An artificially maintained bluegrass lawn was a part of the winter range. The activity of grading/plowing to develop the lawn was responsible for the documented direct impact of attraction to an artificial food source. Sheep conclusively preferred to feed on the green vegetation of the lawn and on green seral vegetation in an area burned in 1936 during early and mid-winter, and on unburned climax bunchgrass after it resumed growth earlier in spring than the seral vegetation or lawn. Climax bunchgrass communities provided the most forage under the harshest winter conditions of deep or crusted snow, however. If seral vegetation would be available in winter, allowing natural fires to burn could benefit sheep by increasing productivity of forage species and by removing trees, if some climax bunchgrass remained in sheep winter range.

Activity: grading/plowing.

Impact: attraction to artificial food source.

Robinson, R.M., T.L. Hailey, C.W. Livingston, and J.W. Thomas. 1967. Bluetongue in the desert bighorn sheep. J. Wildl. Manage. 31(1):165-168. (UAF)*

In this field and laboratory research article, a case of bluetongue, a disease of domestic sheep, was observed and confirmed in a young (about 8 mo old) desert bighorn ram on the Black Gap Wildlife Management Area, Brewster County, Texas, on an unstated date. Bighorns are closely related to Dall sheep and are susceptible to the same diseases. Although the latitude of the study site and the habitat types of desert grasslands and open, dry coniferous forests are not comparable to those of Dall sheep in Alaska, transmission of viral disease is not dependent on habitat similarity. The activity of grazing was responsible for the documented direct impact of disease transmission. Conclusive results showed that the bighorn became ill from bluetongue and died from resulting pneumonia. Bluetongue was first seen in bighorns in west Texas after free-ranging domestic sheep carrying the disease had been introduced; soon thereafter, bighorn disappeared from that region. The insect vector, a Culicoides gnat, cannot be controlled. Mitigation guidelines include keeping domestic livestock, particularly sheep, off large tracts of land suitable for bighorns, or intensively vaccinating domestic livestock in those areas.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Samuel, W.M., G.A. Chalmers, J.G. Stelfox, A. Loewen, and J.J. Thompson. 1975. Contagious ecthyma in bighorn sheep and mountain goat in western Canada. J. Wildl. Dis. 11(1):26-31. (UAF)

In this field and lab research paper, bighorn sheep and mountain goat of all life stages from several national parks in western Canada were examined in 1971 and 1972 for contagious ecthyma (CE), a viral disease of domestic sheep and goats. Bighorn and Dall sheep occupy similar alpine tundra and subalpine boreal forest habitats and are similar in disease responses. The activity of chemical application in the form of salt blocks put out to attract wild sheep and goats for viewing and as road salt in winter resulted in the direct impact of attraction to an artificial food source and the postulated but unproven direct impact of transmission of CE that had originally been introduced from domestic animals. Conclusive results confirmed the presence of CE infections, some lethal, especially in lambs and kids. All infected herds had prolonged contact with areas where salt was artificially provided, and fewer infected sheep were observed annually when salt blocks were removed. The history of CE in wild sheep and goats in western Canada is also discussed.

Activity: chemical application; grazing; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; introduced wild or domestic species, competition with or disease transmission from.

Singer, F.J., and K. Mullen. 1981. Summer distribution and numbers of Dall sheep and mountain goats in Wrangell-St. Elias National Park and Preserve. Prog. rept. USDI:NPS. Anchorage. 15 pp. (ADF&G-F)*

In this field research report, the reactions of Dall sheep and mountain goats of all life stages in Wrangell-St. Elias National Park and Preserve to helicopter disturbance in July of 1981 are discussed. Habitat types include open alpine tundra and cliffs. The activity of transporting personnel/equipment/material by air was responsible for the documented direct impact of active harassment. Conclusive results showed that approaches of the helicopter to an average minimum distance of 82-119 m (90-130 yd) in some cases caused extreme disturbance to sheep and goats, movement by a high proportion of animals at a full run or for a distance greater than 229 m (250 yd), but no visible injuries. Sheep or goats on steep terrain remained still or attempted to hide, whereas those approached away from escape terrain were more likely to run. Sheep habituated to neutral overflights, but those in areas where sheep sightseeing and aerial transport of hunters occurred responded strongly to the helicopter. Rams were less easily harassed than ewes. Most sheep calmed down rapidly if the helicopter was landed. Mitigation recommendations are to avoid circling over sheep or goats, to land rapidly without circling when near sheep or goats, and to veer away at once from any group disturbed into a full run.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Smith, T.C., W.E. Heimer, and W.J. Foreyt. 1982. Contagious ecthyma in an adult Dall sheep (*Ovis dalli dalli*) in Alaska. J. Wildl. Dis. 18(1): 111-112. (UAF)

Dall sheep at Sheep Creek in the central Alaska Range were examined in the spring of 1979 for this field and lab report. The habitat type was alpine tundra. No activity was postulated as responsible for the documented, direct impact of transmission of contagious ecthyma (CE), a disease of domestic sheep and goats. Conclusive results showed CE active in one sheep and antibodies indicative of exposure to CE in 17 of 73 sheep sampled.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Stemp, R. 1982. Heart rate response of bighorn sheep to some environmental factors. Bienn. Symp. North. Wild Sheep and Goat Counc. 3:314-319 (Abstract only.) (ADF&G-F, W. Heimer)*

In this field research study, the effects of various environmental factors, including disturbance by humans and vehicles, on bighorn ewes and on a 2-yr old ram were observed during June, July, and August, 1979 on Ram Mountain, Alberta, Canada. Bighorn sheep are closely related to and behaviorally similar to Dall sheep. Although the area is located south of Alaska the high elevations and continental climate result in similar habitat types of subalpine coniferous forests, shrub stands, and meadows, and alpine tundra. The activities of approach of humans on foot and/or helicopter overflights were responsible for the documented direct impact of active and passive harassment. Sheep in this study were only moderately habituated to disturbance, and sensitization often occurred. A persistent approach of sheep by humans on foot, even at increasing distances, resulted in greater harassment than a single approach. All overpasses by a helicopter, including one at 427 m (1,400 ft), resulted in harassment.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Stevens, D.R. 1982. Bighorn sheep management in Rocky Mountain National Park. Proc. Bienn. Conf. North. Wild Sheep and Goat Counc. 3:244-253. (ADF&G-F, W. Heimer)*

In this field research and review article, the effects of visitor use of critical habitat for bighorn sheep of all life stages in Rocky Mountain National Park, northcentral Colorado, were examined between May 1971 and fall 1981, primarily during the snow-free seasons. Bighorn sheep are closely related to and behaviorally similar to Dall sheep. Although the area is south of Alaska, the high elevations and continental climate result in similar habitat types of mixed aspen-conifer forests with shrub and grassland openings, subalpine coniferous forests, and alpine tundra. The activities of human disturbance and vehicle traffic on a road were responsible for the documented direct impacts of barriers to movement and active and passive harassment. Historical impacts on the sheep populations are summarized from Packard 1946 (q.v.). Sheep attempting to use a mineral lick in a meadow along a major highway were turned back from crossing the highway. Those that reached the lick were disturbed by visitors who stopped and forced them to vacate the area. Sheep attempting to use the other mineral lick, near a trail, were chased out of the lick by amateur photographers and out of meadows nearby into escape terrain by hikers, the sheep leaving the area in both cases. Several mitigation measures were taken. The trail to the second mineral lick was closed to human use. A uniformed park interpreter was stationed beside the road at the first lick throughout the three summer months of heavy visitor use. The interpreter enforced prohibitions against humans entering the meadow from the road and against stopping or walking within two 100-m (328-ft) road-crossing zones for sheep. The activity of grazing of horses also was responsible for the documented indirect impact of vegetation damage of low-elevation winter range, most likely leading to extripation of a local bighorn population. The exact cause of the disappearance of the population was not determined; however, a new population, transplanted after grazing was stopped, is thriving.

Activity: grazing; human disturbance; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to grazing by domestic or introduced animals.

Tracy, D.M. 1977. Reactions of wildlife to human activity along Mount McKinley National Park Road. M.S. Thesis, Univ. Alaska, Fairbanks. xxii + 260 pp. (UAF)*

In this thesis based on field research, moose, Dall sheep, and several furbearers, including red fox, wolf, and lynx, at all life stages and of both sexes were observed during mid May through September of 1973 and 1974 along and adjacent to the road through Mount McKinley National Park. Habitat types include subalpine white spruce forests, tall and low shrub stands, alpine tundra, and wetland and riparian vegetation. The activities of human disturbance and transport of personnel/equipment/material by land were responsible for direct, documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, active and passive harassment, interference with reproductive behavior, alteration of prey base, and vegetation composition change.

Moose. Conclusive results showed that moose did not avoid watersheds traversed by the road. At distances greater than 300 m (984 ft) from the road, moose rarely reacted to human disturbance along the road. At distances less than 200 m (656 ft), loud noises and people quietly getting off busses increased passive harassment by two to three times. Young calves stumbled or rolled down a bank when surprised by hikers or vehicles. Habituation of some moose to moderate disturbances occurred over the course of the summers. Although at distances of less than 200 m (656 ft) only half of the moose showed visible responses to road disturbance, responses such as staring then slowly moving into cover while browsing were not recorded. Willows revegetating cleared roadsides may occasionally attract moose, and one moose was killed by a vehicle collision during this study.

Dall Sheep. Conclusive results show that Dall sheep became habituated to photographers, allowing approaches on foot to within 100 m (328 ft). Some sheep have become habituated to crossing the road between summer and winter range in the presence of people and vehicles, while the movements of others are inhibited by the road. Within 200 m (656 ft) of the road, 32% of sheep showed strong responses to buses and visitors, while no strong responses were noted beyond 400 m (1,312 ft). The percentage of strong responses within 200 m (656 ft) increased from busses passing through to busses stopping to people getting out, and was greatly increased by loud noises. Tentatively, since use of the range where the road runs through sheep habitat was much greater in the past, disturbance may have resulted in abandonment of the range by most sheep.

Furbearers. Conclusive results showed that red fox also did not avoid the vicinity of the road, for hunting or denning. Foxes more than 100 m (328 ft) from the road rarely responded strongly to disturbance, but mild responses were observed to 600 m (1,968 ft). Habituation to disturbance readily occurs. Foxes hunt and travel along the road and are sometimes fed by visitors.

Wolves use the road for travel, especially in winter when it is closed, scavenge road kills, and become beggars when fed by visitors. Wolves are infrequently strongly disturbed while killing or feeding within 200 m (656 ft) of the road.

Lynx, on the three occasions sighted, showed only mild reactions to vehicles on the road 200 m (656 ft) away and to a quiet human 100 m (328 ft) away.

Hares, prey for several furbearers, were attracted to roadside artificial and natural revegetation, the latter in early spring and the former during the summer. A man-made mineral lick along the road also attracted hares.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

USDI. 1976a. Alaska natural gas transportation system - final environmental impact statement. Washington, D.C. (ARL)#*

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes (altitudes were not stated).
2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.
3) Muskoxen may have shifted their traditional summer range by 25.6 km (16 mi) in response to heavy helicopter traffic.
4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.
5) Muskoxen and Canadian geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.
2) Caribou can apparently tolerate winter blasting if they are not hunted.
3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.
4) Waterfowl with young avoid drilling rigs within a 4.3 km (2-2/3 mi) radius.

Activity: blasting; transport of oil/gas/water - land; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Wishart, W.D., J. Jorgenson, and M. Hilton. 1980. A minor die-off of bighorns from pneumonia in southern Alberta (1978). Pages 229-247 in W.O. Hickey, chairman. Proceedings of the biennial symposium of the northern wild sheep and goat council, Salmon, ID, April 23-25. (ADF&G-F, W. Heimer)*

In this field research study, the effects of lungworms on bighorn sheep of all life stages were examined along the Sheep River, about 50 km (31 mi) southwest of Calgary, southern Alberta, Canada, between September 1978 and late winter 1980. Bighorn sheep are closely related to Dall sheep and susceptible to similar parasites. Although the study area is south of Alaska, the high elevation and continental climate result in similar habitat types of mountain mixed and coniferous forest and aspen parklands, shale walls, and grassy meadows. The activity of human disturbance was responsible for the documented direct impacts of increased susceptibility to parasitism. Conclusive results are that after the bighorn winter range was declared a sanctuary in which hunting was prohibited in 1973, more and more sheep have been returning to concentrate on the winter range in late summer and early fall to avoid hunters and/or hikers, rather than returning in late fall or early winter. Snails, the intermediate host for lungworm larvae, are still active in late summer and early fall and transmit unusually large numbers of larvae to sheep. Some sheep (10% in this case) then die of pneumonia by late October. Management recommendations are to prevent bighorns from returning to the winter range during summer and early fall and to delay hunting seasons until mid September or later to discourage bighorns from congregating too early in their contaminated sanctuary.

Activity: human disturbance.

Impact: parasitism and predation, increased susceptibility to.

Woodard, T.N., R.J. Gutierrez, and W.H. Rutherford. 1974. Bighorn lamb production, survival and mortality in southcentral Colorado. J. Wildl. Manage. 38(4):771-774. (UAF)

In this field research paper, a bighorn sheep herd was observed in the Sangre de Cristo Mountains of Colorado during the spring, summer, and fall of 1969 and the summer and fall of 1970. Bighorn sheep and Dall sheep are susceptible to similar diseases, both utilize restricted winter ranges, and the alpine tundra and open subalpine forest habitat of the Rocky Mountains is comparable, in terms of sheep utilization patterns, to Alaskan habitats. The activities of grading/plowing, grazing, and clearing are tentatively proposed as responsible for the documented direct impact of increased susceptibility to parasitism. The bighorn herd is decreasing because of low survival of lambs due to a lungworm-caused pneumonia complex. Historic winter range has been lost because of livestock grazing and subdivision. Further development of the winter range is expected to increase stress on the bighorn sheep herd.

Activity: clearing and tree harvest; grading/plowing; grazing.

Impact: parasitism and predation, increased susceptibility to.

12. Furbearers

Table 1. Impacts Associated With Each Activity - Furbearers

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove		X	X		?		X			X		?	X		?							?	?							?
Aquatic vegetation, destruction or change			X		X	?	X			X					?			?					?							X
Attraction to artificial food source				?	X							X	X	X							?	X			X			X		
Barriers to movement, physical and behavioral		?	?		X	?	?		X			?		?					?						?			?		?
Collision with vehicles or structures																												X		
Entanglement in fishing nets, debris					?				?							?														
Entrapment in impoundments or excavations												?										?						?		?
Harassment, active or passive	X		?		?	?	?	?		?	?	?	?	X	?		?	?	X	?	?	?			X	?	X	X	?	?
Harvest, change in level		?			X	?	?	?				X		X			?	?							X			X	?	?
Introduced wild/domestic species, competition													?	X																?
Morbidity/mortality by ingestion of petroleum				X				?												?					X					
Parasitism/predation, increased susceptibility					?									?																X
Prey base, alteration of		?	X		X	?	?			?		X	?															X		?
Shock waves (increase in hydrostatic pressure)	?																													
Terrain alteration or destruction	?		X				X			X	?	?			?							?						X		?
Veg. composition, change to less preferred		?			X	?						?	?							?										X
Veg. damage/destruction due to air pollution				?															?	?										
Veg. damage/destruction due to fire/parasitism		X																												
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion		?	X		X	?	X			X		X			?				?											
Water level or water quality fluctuations			X		X	?	X			X			X								X				X					X

X - Documented impact (see text).
? - Potential impact.

12. FURBEARERS - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on furbearers. Each citation refers to an annotation in the following section, Annotated References to Impacts on Furbearers. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to furbearers are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to furbearers were found for the following activities:

Draining
Drilling
Filling (terrestrial)
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing oil/gas
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - water
Transport of personnel/equipment/material - water

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Sopuck et al. 1979

2. Burning:

   a. Aquatic substrate materials

Sopuck et al. 1979

b. Veg. damage/destruction due to fire/parasitism

Sopuck et al. 1979
Stephenson 1984

3. Channelizing waterways:

a. Aquatic substrate materials

Arner et al. 1975
Gray and Arner 1977

b. Aquatic vegetation, destruction or change

Arner et al. 1975

c. Prey base, alteration of

Gray and Arner 1977

d. Terrain alteration or destruction

Gray and Arner 1977
Simpson et al. 1982

e. Veg. damage/destruction due to erosion

Simpson et al. 1982

f. Water level or water quality fluctuations

Gray and Arner 1977

4. Chemical application:

a. Morbidity/mortality by ingestion of petroleum

Preston 1983b

5. Clearing and tree harvest:

a. Aquatic vegetation, destruction or change

Sopuck et al. 1979

b. Attraction to artificial food source

    Sopuck et al. 1979

c. Barriers to movement, physical and behavioral

    Sopuck et al. 1979

d. Harvest, change in level

    Klebesadel and Restad 1981

e. Prey base, alteration of

    Elliott 1983
    Sopuck et al. 1979

f. Veg. composition, change to less preferred

    Elliott 1983
    Sigman 1985
    Sopuck et al. 1979

g. Veg. damage/destruction due to erosion

    Baxter and Glaude 1980
    Klebesadel and Restad 1981
    Ruttan and Wooley 1974
    Sigman 1985
    Slough and Sadlier 1977
    Sopuck et al. 1979

h. Water level or water quality fluctuations

    Sopuck et al. 1979

6. Dredging:

a. Aquatic substrate materials

    Joyce 1980

b. Aquatic vegetation, destruction or change

    Joyce 1980

c. Terrain alteration or destruction

    Joyce et al. 1980

d. Veg. damage/destruction due to erosion

Joyce 1980
Joyce et al. 1980

e. Water level or water quality fluctuations

Joyce 1980
Joyce et al. 1980

7. Fencing:

a. Barriers to movement, physical and behavioral

DeCalesta 1983
DeLorenzo 1977
Gates 1978
Jepson et al. 1983
Lokemoen et al. 1982
Preston 1983b

8. Filling and pile-supported structures (aquatic):

a. Aquatic substrate materials

Joyce 1980

b. Aquatic vegetation, destruction or change

Joyce 1980

c. Terrain alteration or destruction

Joyce et al. 1980

d. Veg. damage/destruction due to erosion

Joyce 1980
Joyce et al. 1980

e. Water level or water quality fluctuations

Joyce 1980
Joyce et al. 1980

9. Grading/plowing:

a. Attraction to artificial food source

Elliott 1983
Preston 1983b

b. Harvest, change in level

Klebesadel and Restad 1981

c. Prey base, alteration of

Elliott 1983

d. Veg. damage/destruction due to erosion

Klebesadel and Restad 1981

10. Grazing:

a. Aquatic substrate materials

Yeager and Hill 1954

b. Attraction to artificial food source

DeCalesta 1983
DeLorenzo 1977
Gates 1978
Jepson et al. 1983
Klebesadel and Restad 1981
Preston 1983b

c. Veg. damage/destruction due to grazing

Yeager and Hill 1954

d. Water level or water quality fluctuations

Yeager and Hill 1954

11. Human disturbance:

a. Attraction to artificial food source

Milke 1977
Tracy 1977

b. Harassment, active or passive

Ballard et al. 1982
Bangs et al. 1982
Elliott 1983
Gipson et al. 1982
Milke 1977
Ruttan 1974
Sopuck et al. 1979
Tracy 1977

c. Harvest, change in level

Bangs et al. 1982
Milke 1977
Sopuck et al. 1979

d. Introduced wild/domestic species, competition

Bangs et al. 1982

12. Processing minerals (including gravel):

a. Harassment, active or passive

Bangs et al. 1982

13. Sewage disposal:

a. Water level or water quality fluctuations

Arner et al. 1975

14. Solid waste disposal:

a. Attraction to artificial food source

Milke 1977

15. Transport of oil/gas/water - land, ice:

a. Attraction to artificial food source

Hanley et al. 1981

b. Harassment, active or passive

Milke 1977

Reynolds 1974

c. Harvest, change in level

Klein 1979

d. Morbidity/mortality by ingestion of petroleum

Peller 1963

e. Water level or water quality fluctuations

Peller 1963

16. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Ballard et al. 1982
Gipson et al. 1982
Klein 1973
Milke 1977
Ruttan 1974
USDI 1976a

17. Transport of personnel/equipment/material - land, ice:

a. Attraction to artificial food source

Tracy 1977

b. Collision with vehicles or structures

Milke 1977

c. Harassment, active or passive

Elliott 1983
Milke 1977
Slough and Sadlier 1977
Sopuck et al. 1979
Tracy 1977

d. Harvest, change in level

Klein 1979

e. Prey base, alteration of

Tracy 1977

f. Terrain alteration or destruction

Ruttan 1974

18. Water regulation/withdrawal/irrigation:

a. Aquatic vegetation, destruction or change

Baxter and Glaude 1980
Slough and Sadlier 1977
Sopuck et al. 1979

b. Parasitism/predation, increased susceptibility

Sopuck et al. 1979

c. Veg. composition, change to less preferred

Sopuck et al. 1979
Vinogradov and Chernyavskoya 1976

d. Water level or water quality fluctuations

Baxter and Glaude 1980
Berghofer 1961
Collins 1976
Gill 1973
Sopuck et al. 1979
Vinogradov and Chernyavskoya 1976

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to furbearers were found for the following categories:

Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Shock waves (increase in hydrostatic pressure)
Veg. damage/destruction due to air pollution

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Aquatic substrate materials:

   a. Burning

      Sopuck et al. 1979

   b. Channelizing waterways

      Arner et al. 1975
      Gray and Arner 1977

   c. Dredging

      Joyce 1980

   d. Filling and pile-supported structures (aquatic)

      Joyce 1980

   e. Grazing

      Yeager and Hill 1954

2. Aquatic vegetation, destruction or change:

   a. Channelizing waterways

      Arner et al. 1975

   b. Clearing and tree harvest

      Sopuck et al. 1979

c. Dredging

Joyce 1980

d. Filling and pile-supported structures (aquatic)

Joyce 1980

e. Water regulation/withdrawal/irrigation

Baxter and Glaude 1980
Slough and Sadlier 1977
Sopuck et al. 1979

3. Attraction to artificial food source:

a. Clearing and tree harvest

Sopuck et al. 1979

b. Grading/plowing

Elliott 1983
Preston 1983b

c. Grazing

DeCalesta 1983
DeLorenzo 1977
Gates 1978
Jepson et al. 1983
Klebesadel and Restad 1981
Preston 1983b

d. Human disturbance

Milke 1977
Tracy 1977

e. Solid waste disposal

Milke 1977

f. Transport of oil/gas/water - land, ice

Hanley et al. 1981

g. Transport of personnel/equipment/material - land, ice

Tracy 1977

4. Barriers to movement, physical and behavioral:

    a. Clearing and tree harvest

        Sopuck et al. 1979

    b. Fencing

        DeCalesta 1983
        DeLorenzo 1977
        Gates 1978
        Jepson et al. 1983
        Lokemoen et al. 1982
        Preston 1983b

5. Collision with vehicles or structures:

    a. Transport of personnel/equipment/material - land, ice

        Milke 1977

6. Harassment, active or passive:

    a. Blasting

        Sopuck et al. 1979

    b. Human disturbance

        Ballard et al. 1982
        Bangs et al. 1982
        Elliott 1983
        Gipson et al. 1982
        Milke 1977
        Ruttan 1974
        Sopuck et al. 1979
        Tracy 1977

    c. Processing minerals (including gravel)

        Bangs et al. 1982

    d. Transport of oil/gas/water - land, ice

        Milke 1977

Reynolds 1974

e. Transport of personnel/equipment/material - air

Ballard et al. 1982
Gipson et al. 1982
Klein 1973
Milke 1977
Ruttan 1974
USDI 1976a

f. Transport of personnel/equipment/material - land, ice

Elliott 1983
Milke 1977
Slough and Sadlier 1977
Sopuck et al. 1979
Tracy 1977

7. Harvest, change in level:

a. Clearing and tree harvest

Klebesadel and Restad 1981

b. Grading/plowing

Klebesadel and Restad 1981

c. Human disturbance

Bangs et al. 1982
Milke 1977
Sopuck et al. 1979

d. Transport of oil/gas/water - land, ice

Klein 1979

e. Transport of personnel/equipment/material - land, ice

Klein 1979

8. Introduced wild/domestic species, competition:

a. Human disturbance

Bangs et al. 1982

9. Morbidity/mortality by ingestion of petroleum:

    a. Chemical application

        Preston 1983b

    b. Transport of oil/gas/water - land, ice

        Peller 1963

10. Parasitism/predation, increased susceptibility:

    a. Water regulation/withdrawal/irrigation

        Sopuck et al. 1979

11. Prey base, alteration of:

    a. Channelizing waterways

        Gray and Arner 1977

    b. Clearing and tree harvest

        Elliott 1983
        Sopuck et al. 1979

    c. Grading/plowing

        Elliott 1983

    d. Transport of personnel/equipment/material - land, ice

        Tracy 1977

12. Terrain alteration or destruction:

    a. Channelizing waterways

        Gray and Arner 1977
        Simpson et al. 1982

    b. Dredging

        Joyce et al. 1980

    c. Filling and pile-supported structures (aquatic)

Joyce et al. 1980

d. Transport of personnel/equipment/material - land, ice

Ruttan 1974

13. Veg. composition, change to less preferred:

a. Clearing and tree harvest

Elliott 1983
Sigman 1985
Sopuck et al. 1979

b. Water regulation/withdrawal/irrigation

Sopuck et al. 1979
Vinogradov and Chernyavskoya 1976

14. Veg. damage/destruction due to fire/parasitism:

a. Burning

Sopuck et al. 1979
Stephenson 1984

15. Veg. damage/destruction due to grazing:

a. Grazing

Yeager and Hill 1954

16. Veg. damage/destruction due to erosion:

a. Channelizing waterways

Simpson et al. 1982

b. Clearing and tree harvest

Baxter and Glaude 1980
Klebesadel and Restad 1981
Ruttan and Wooley 1974
Sigman 1985
Slough and Sadlier 1977
Sopuck et al. 1979

c. Dredging

Joyce 1980
Joyce et al. 1980

d. Filling and pile-supported structures (aquatic)

Joyce 1980
Joyce et al. 1980

e. Grading/plowing

Klebesadel and Restad 1981

17. Water level or water quality fluctuations:

a. Channelizing waterways

Gray and Arner 1977

b. Clearing and tree harvest

Sopuck et al. 1979

c. Dredging

Joyce 1980
Joyce et al. 1980

d. Filling and pile-supported structures (aquatic)

Joyce 1980
Joyce et al. 1980

e. Grazing

Yeager and Hill 1954

f. Sewage disposal

Arner et al. 1975

g. Transport of oil/gas/water - land, ice

Peller 1963

h. Water regulation/withdrawal/irrigation

Baxter and Glaude 1980

Berghofer 1961
Collins 1976
Gill 1973
Sopuck et al. 1979
Vinogradov and Chernyavskoya 1976

ANNOTATED REFERENCES TO IMPACTS TO FURBEARERS

The annotated bibliography contains only references that discuss documented impacts to furbearers. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to furbearers are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Arner, M.M., H.R. Robinette, J.E. Frasier, and M. Gray. 1975. Effects of channel modification on the Luxapalila River. Pages 77-96 in R.V. Corning, ed., Symposium on stream channel modifications, proceedings. Harrisonburg, VA. August 15-17, 1975. 172 pp. (HD)#

Biological data collected over a period of two years from an old channelized segment, an unchannelized segment, and a newly channelized segment of the Luxapalila River in Mississippi revealed the following: there were no evident differences in water quality between the three segments, with the exception of turbidity which was higher in the newly channelized segment, possibly due to the influence of sewage. Species diversity of macroinvertebrates and fish was much greater in the unchannelized segment. The average weight of largemouth bass was much greater in the unchannelized than in either of the channelized segments. Utilization of an expanding habitat created by annual flooding is indicated by the number of species of game fish collected behind the levees and the preponderance of terrestrial invertebrates found in their stomachs. Indices of abundance of furbearers associated with the river were obtained by night lighting, sign count, and trapping. Muskrat and beaver, the species most commonly associated with an aquatic habitat, were far more numerous in the unchannelized segment than in either the old or new channelized segments.

Activity: channelizing waterways; sewage disposal.

Impact: aquatic substrate materials, addition or removal; aquatic vegetation, destruction or change in composition; water level or water quality fluctuations.

Ballard, W.B., C.L. Gardner, J.H. Westlund, and J.R. Dau. 1982. Susitna Hydroelectric Project. Phase 1 final rept.: Big game studies. Vol. 5: Wolf. ADF&G, Juneau. (ADF&G-F)*

In this field research report, the responses of adult wolves of both sexes in the Susitna River basin to close observation and radio telemetry studies between 1976 and 1981 at all seasons of the year are discussed. Most work was performed in 1980 and 1981. Habitat types range from alpine tundra to boreal forest. Observation of wolf dens and rendezvous sites from helicopters and on foot was responsible for the documented direct impact of harassment. Conclusive results showed that wolves at a den site were frightened by direct helicopter overflights at an unstated altitude and were disturbed by a research camp 0.4 km (0.25 mi) away but became habituated to overflights and did not abandon the den. A single visit by researchers on the ground to one active den between 4 and 6 June in each of 2-yr and to another den in 1 yr, in all three cases resulted in den abandonment without increasing pup mortality. In the early morning and late evening, fewer members of a pack are at an active den, but at no time are all adult members absent. Mitigation guidelines include the following: 1) avoid approaching active wolf dens on the ground within a radius of 2.4 km (1.5 mi) (Chapman 1976); and 2) if closer approaches are absolutely essential, make them after 4 June, in the late evening or early morning.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Bangs, E.E., T.H. Spraker, T.N. Bailey and V.D. Berns. 1982. Effects of increased human populations on wildlife resources of the Kenai Peninsula, Alaska. Trans. N. Am. Wildl. Nat. Resour. Conf. 47:605-616. (UAF).

This paper reviews the historical impacts, management techniques and potential human impacts on trumpeter swans, bald eagles, salmon, wolves, caribou and moose on the Kenai Peninsula, Alaska. Information reviewed dates to the early 1900's, although the majority of the impact related information is from the 1960's and 1970's. Habitat types in the area range from coastal forest to alpine tundra.

Trumpeter swans - The activity of human disturbance produced the direct documented and potential impacts of active and passive harassment and interference with reproductive behavior. Human disturbance associated with residential and industrial development was suspected to have caused abandonment of a spring staging area and several nest sites. Continued disturbance was expected to occur with further human development within the area.

Bald Eagle - The activities of human disturbance and transport of personnel/equipment/material by water produced documented direct impacts of active and passive harassment and interference with reproductive behavior. Eaglet production was substantially less in areas subjected to human disturbance than in areas subjected to little disturbance. Potential impacts that may be associated with roads and transmission lines from the Bradley Lake power project include electrocution from contact with powerlines and passive harassment.

Moose - The activities of human disturbance and transport of personnel, equipment and material by land resulted in direct, documented impacts of collision with vehicles and increased susceptibility to predation. Conclusive results show that between 1970 and 1980, an average of 150 moose were killed annually be collisions, and an undetermined number of calves were killed by domestic dogs.

Wolves - The activities of human disturbance and processing of minerals resulted in direct, documented impacts of disease transmission from domesticated animals, passive harassment and drastically increased harvest. By 1915, widespread use of poison and unregulated hunting and trapping had extirpated wolves from the Kenai Peninsula. After recolonization, it is believed that at least one wolf pack has been reduced by contracting distemper from domestic dogs. Avoidance of intensively developed lands has reduced wolf habitat on the Kenai Peninsula.

Activity: human disturbance; processing minerals (including gravel).

Impact: harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from.

Baxter, R.M., and P. Glaude. 1980. Environmental effects of dams and impoundments in Canada. Can. Bull. Fish and Aquatic Sci. 205. (UAF)#

One section of this publication discusses the effects of flooding and the question of pre-clearing. The authors suggest that the shoreline ecotone is important as a habitat for many species. In the James Bay region, for example, it provides food and shelter for ptarmigan (*Lagopus lagopus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), and various species of waterfowl. It follows that the linear extent of shoreline flooding may be as important for its influence on wildlife as the areal extent of flooding. The development of a new shoreline habitat will take longer the more severe the climate and is likely to be made more difficult by the practice of drawdown.

In general it would seem reasonable to harvest as many as possible before flooding. Some attempts have been made to relocate beaver in areas affected by the James Bay project.

Activity: clearing and tree harvest; water regulation/withdrawal/irrigation.

Impact: aquatic vegetation, destruction or change in composition; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Berghofer, C.B. 1961. Movement of beaver. Pages 181-184 in Proc. 41st Ann. Conf. W. Assoc. Fish and Wildl. Agencies. 295 pp. (GD)#

This paper documents information related to beaver movements in New Mexico based on 397 ear-tagged individuals. Two causes of territorial abandonment and movement were destruction of dwellings by high water and changing water conditions. Depletion of food supplies and overpopulation also caused beavers to leave an area.

Activity: water regulation/withdrawal/irrigation.

Impact: water level or water quality fluctuations.

Collins, T.C. 1976. Stream flow effects on beaver populations in Grand Teton National Park. Pages 277-281 in Proc. First Conf. Sci. Res. in Natl. Parks, Nov. 9-13, 1976. New Orleans, LA. (USFWS)#*

The specific objective of this paper was to assess the influence of streamflow regimes on beaver population abundance, distribution, and movements in one dam-regulated stream and two unimpeded streams. Beaver abandonments of dwellings due to high water levels are common in this area. However, in September, when flow rates were drastically reduced by two-thirds on the dam-regulated stream, 66% of the colonies abandoned their summer dwellings. A similar pattern occurred on the unimpeded streams, but these low-water abandonments occurred in late July, leaving sufficient time for reestablishment of colonies in other locations before the onset of winter climatic conditions. Maximum flow rates on the Snake River at the Jackson Lake Dam occurred several weeks earlier than on the two unimpeded streams. Low flow rates on the Snake River at the dam occur five to seven weeks later than on the two unimpeded streams.

Activity: water regulation/withdrawal/irrigation.

Impact: water level or water quality fluctuations.

deCalesta, D. 1983. Building an electric antipredator fence. Pacific Northwest Cooperative Extension Bull. 225. Univ. Oregon. January. (ADF&G-F) *

This brief review and guidelines paper describes fences that block the movement of coyotes of all life stages in Idaho, North Dakota, and Oregon. Although the latitude of the study area is south of that of Alaska and the habitat types of short grass prairie, cold deserts, and coniferous and mixed forests are not comparable to those of Alaska, the responses of coyotes in Alaska, as well as of wolves or foxes, are expected to be similar. Dates of the original studies reviewed in this article are not stated. The activity of grazing of domestic sheep was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Twelve-wire electric fences absolutely prevent access by coyotes, but seven- or nine-wire fences are more economical. Nine-wire fences are very seldom crossed by coyotes, but some will jump over seven-wire fences. A standard wire mesh sheep fence 99 cm (39 in) high can be renovated by offsetting two electric wires by a distance of 15 to 20 cm (6 to 8 in) from the fence 15 cm (6 in) above the bottom and below the top with an optional wire offset along the center of the fence. The original fence is negatively charged, and the offset smooth wires are positively charged. Such a fence decreases predation losses by 80 to 100%. A single positively charged wire can be offset along the top or bottom of a predator-directing fence that coyotes have learned to dig under or climb over. For a seven-wire all-electric coyote fence, the high tensile smooth wires should be strung at the following spacing, from the ground up: 13, 15, 15, 20, 20, 25, and 25 cm (5, 6, 6, 8, 8, 10, and 10 in). For a nine-wire fence, the spacing should be 13, 15, 15, 15, 20, 20, 20, 25, and 25 cm (5, 6, 6, 6, 8, 8, 8, 10, and 10 in). In each case, alternate wires should be positively charged, starting with the top wire, and the other wires grounded. When the ground is wet, all wires may be positively charged. An uncharged strand of barbed wire at ground level will discourage coyotes from digging under the fence. If needed to prevent coyotes from digging under or jumping over, stretch a smooth positively charged trip wire 15 to 20 cm (6 to 8 in) in front of the fence and 15 to 20 cm (6 to 8 in) above the ground. See the article for other specifications and recommendations for constructing and maintaining high-tensile electric fences.

Activity: fencing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

DeLorenzo, D.G. 1977. Fencing against coyotes. Oregon State Univ. Extension Service Circular 916. 3 pp. (ADF&G-F)*

This brief field research and design specifications paper describes woven wire fences that block the movements of coyotes of all life stages in western Oregon. Although Oregon is at a more southerly latitude than Alaska and the habitat types of cold desert and dry grassland are not comparable to those of Alaska, the responses of coyotes to the fences are expected to be the same. The directing fence was tested on sheep ranches, and the deterrent fence was tested with penned coyotes, but the dates of the tests are not stated. The activity of grazing domestic sheep was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Both fences are constructed of woven wire mesh in which the horizontal wires are 4 cm (1.5 in) apart at ground level and 10 cm (4 in) apart at the top and are supported by posts at 4.6-m (15-ft) intervals. On both, a woven wire apron 61 cm (24 in) wide is attached to the bottom of the fence, extending outward. The vertical woven wire for the directing fence, which forces coyotes to cross at identifiable locations where they can be trapped, is 1.5 m (59 in) high, and a single strand of barbed wire should be strung 15 cm (6 in) above the woven wire. For the deterrent fence, the woven wire should be 1.8 m (72 in) high, and the top 41 cm (16 in) should be bent outward at a 45° angle and attached to supports to form an overhang that deters coyotes from climbing or jumping over the fence. Suggestions for improving the efficiency of the fences and lists of materials and costs are also provided.

Activity: fencing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Elliott, C. 1983. Food habits and habitat characteristics of wildlife species utilizing revegetated strip mine lands in Alaska. Exhibit IV-5 in Poker Flats mine permit application, Usibelli Coal Mine. June. (ADF&G-F)*

In this field research report, the effects of revegetation of strip mined lands near Healy, Alaska, on all life stages of 26 species of mammals and birds, including coyote, fox, moose, sheep, and wolf, during all seasons of the year from 1980 to 1982 were examined. Undisturbed habitat types in this area of the northern foothills of the Alaska Range included open and closed spruce forest, shrub tundra, and barren floodplain. Areas disturbed 33 to 40 years before the study had naturally revegetated to tall shrub habitat; other areas had been revegetated to grasses in 1972, 1976, and 1979. The activities of grading/plowing, human disturbance, and transport of personnel/equipment/material by land were responsible for documented direct impacts of attraction to artificial food source and passive harassment, and indirect impact of alteration of prey base. Potential impacts are also discussed. Conclusive results by species follow, then mitigation guidelines for all species.

Carnivorous furbearers. The absence of hares in areas revegetated to grasses has decreased prey availability for coyotes and, to a lesser degree, for wolves and foxes. Wolves avoid hunting in areas of frequent human presence but seek Dall sheep grazing in a revegetated area in winter.

Moose. Summer and winter browsing areas for moose have been eliminated in areas revegetated to grasses, whereas shrub stands in naturally revegetated roadsides and mined areas attract moose.

Sheep. One mined area that includes revegetated grass stands near a steep headwall and that winds keep snow-free provides low quality sheep winter range, used in conjunction with natural tundra.

Mitigation guidelines are 1) promote a diversity of vegetation on areas to be mined and eventually reclaimed, by reserving areas such as riparian shrub zones and by avoiding reseeding to monotypic grass stands; 2) construct haul roads with as low a berm as possible; 3) place uprooted trees and brush in piles adjacent to undisturbed areas (as cover); 4) reseed disturbed areas to native plants; and 5) if seeding to grasses, use red fescue and bluejoint, the species most beneficial to wildlife.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); prey base, alteration of; vegetation composition, change to less preferred or useable species.

Gates, N. 1978. Constructing an effective anticoyote electric fence. USDA Leaflet No. 565. Washington, D.C. 6 pp. (ADF&G-F)*

This field research report describes a fence that was tested and modified in Dubois, Idaho, at an unstated time and that was proven to be effective in preventing coyotes of all life stages from killing domestic sheep. Although the geographic area is at a more southerly latitude than Alaska and the habitat types of shortgrass prairie, cold desert, and coniferous and mixed forests are not directly comparable to those in Alaska, the effects of fences on coyotes are expected to be similar. The activity of grazing was responsible for the documented direct impact of attraction to an artificial food source (domestic sheep), and the activity of fencing was responsible for the documented direct impact of barriers to movement. The recommended fence, known as the Piesse predator fence, consists of 12 smooth, high-tensile wires strung on vertical posts to a total height of 1.5 m (5 ft). Alternating wires are positively charged, starting with the top wire; the remaining wires are grounded. The wires are spaced as follows, starting with the distance from the surface of the soil to the lowest wire and going up the fence: 10, 10, 10, 10, 10, 13, 13, 15, 15, 15, 15, and 15 cm (4, 4, 4, 4, 4, 5, 5, 6, 6, 6, 6, and 6 in). An additional charged trip wire should be strung at a height of 15 cm (6 in) and at a distance of 20 cm (8 in) outside the fence. In extremely sandy soil, a coyote could dig under both the trip wire and the fence. Line posts should be spaced at intervals of 20 m (66 ft), stays installed the full height of the fence every 6.7 m (22 ft), and stays installed on the bottom six wires between each pair of full height stays or posts to maintain wire spacing every 3.4 m (11 ft). See the article for other recommendations for constructing and maintaining the high-tensile electric fence.

Activity: fencing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Gill, D. 1973. Modification of northern alluvial habitats by river development. Canad. Geogr. 17(2):138-153. (UAF)*

In this review and discussion article, the effects of impoundment or diversion of northern rivers on downstream areas, particularly the effects of the impoundment of the Peace River on the Peace-Athabasca Delta of northeastern Alberta, Canada, are described. Impacts are documented on all life stages of bison, freshwater fish, furbearers (muskrat), and moose; potential impacts for which detailed mechanisms are explained are described on ducks, geese, beaver, mink, and caribou. The area is at the latitude of south-central Alaska but with a continental climate comparable to that of interior Alaska. Dates of the field studies discussed are not stated, but the Bennett Dam on the Peace River was closed in 1969, and the major symposium on the effects was held in January 1971. Both winter and summer research is described. Habitat types include all low-elevation boreal forest types: mixed and white spruce forests, black spruce stands, muskeg, shallow lakes and sedge meadows and wetlands, and successional stands of willows along watercourses. The activity of impoundment of the river was responsible for the documented indirect impact on furbearers of decreased water levels below the dam and for the documented indirect impact on moose of vegetation succession due to decreased water levels and the absence of the scouring effects of the spring flood. Conclusive results are that very few muskrats overwintered in the delta since the dam was closed because the shallow lakes freeze to the bottom, killing the muskrats. Harvest of pelts two years after closure of the dam was only 3% of the average harvest for 9 yr prior to closure. Willow stands suitable as moose browse have temporarily increased, replacing shallow marsh Carex meadows, but are being replaced more slowly by spruce, which is used only for cover by moose. Mitigation recommendations are the following: 1) duplicate the natural flow regime as closely as possible below dams used for hydroelectric power, rather than impounding a maximum amount of spring runoff; and 2) avoid impounding northern rivers for diversion, because maintenance of near natural flows below the impoundments would be impossible and the habitat for fish and wildlife would markedly deteriorate.

Activity: water regulation/withdrawal/irrigation.

Impact: water level or water quality fluctuations.

Gipson, P.S., S.W. Buskirk, and T.W. Hobgood. 1982. Susitna Hydroelectric Project furbearer studies. Phase I report. Alaska Cooperative Wildlife Research Unit. 81 pp. April. (HD)*

During 1980 and 1981, furbearer populations within 12 km (7.5 mi) of the proposed impoundments of the Susitna Hydroelectric Project and along the floodplain of the Susitna River downstream of the project were assessed through field research and potential impacts estimated from a literature review. Habitat types in the study area included riparian shrub, white and black spruce forest, and at higher elevations riparian forests and tundra associations. Activities associated with dam construction responsible for potential impacts are clearing, grading/plowing, human disturbance, transport of personnel/equipment/material - air, and water regulation/withdrawal. The direct documented impact to red foxes and marten during the study included active and passive harassment. Juvenile foxes responded negligibly to helicopters at distances over 500 m (1,640 ft), with curiosity at 300 m (984 ft), and increasing excitement at closer approaches. Adult foxes were much more alert, often moving away from dens when helicopters were 1,600 m (5,248 ft) away, possibly due to radio-collaring and location by helicopter. Adult foxes noticed humans on foot at 400 to 500 m (1,312 to 1,640 ft) and barked warnings at 100 to 150 m (328 to 492 ft). Repeated disturbance of dens in no case caused abandonment. Marten fled researchers who were on foot or in helicopters before detection.

Mitigation techniques are suggested. Designation of replacement lands is the only means of offsetting habitat loss due to flooding and permanent structures, including roads. Roads and borrow areas should avoid wetlands, white spruce stands, and fox dens. Topsoil should be replaced on borrow areas and heterogeneous shrub and graminoid vegetation reestablished by fertilizing and seeding. Similar vegetation should be established in cleared transmission line corridors, increasing habitat for small mammals, birds, and hares, which might be utilized by fox, marten, weasel, coyote, and possibly lynx. Camp facilities and landfills could be fenced, refuse should be properly disposed of, workers educated, and state laws against feeding wild animals strictly enforced. The use of ATVs should be restricted in areas made more accessible by the project.

This article also contains detailed information on furbearer abundance and ranges specific to the study area.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gray, M.M., and D.M. Arner. 1977. The effects of channelization on furbearers and furbearer habitat. Proc. Ann. Conf. S.E. Assoc. Fish Wildl. Agencies 31:259-265. (HD)#*

This paper reported four times as many beavers along an unchannelized stream segment, as compared to a segment that had been channelized 55 years earlier. Twice as many beavers were found along an unchannelized segment, as compared to a newly channelized segment. Low water precluded underwater burrows. The data indicated that habitat for beaver, muskrat, and racoon has been damaged by channelization and has not fully recovered even after a period of 55 years and complete reversion to polewood-size hardwoods with abundant herbaceous vegetation in the riparian areas.

It appears that the greatest damage has been done in the reduction of suitable denning areas for muskrat and beaver. The deposition of sand and gravel from dredging and upstream erosion has, for all practical purposes, destroyed den sites in both the channelized segments. In addition, water depth in the channelized segments of this river becomes extremely low at different periods of the year. Very often water depth was below 15.2 cm (0.5 ft) for as long as four or more weeks at a time. Such water depths would preclude construction of underwater entrances for beaver and muskrat. The deposition of sand and gravel undoubtedly adversely affects riverine food sources for raccoon and mink.

Activity: channelizing waterways.

Impact: aquatic substrate materials, addition or removal; prey base, alteration of; terrain alteration or destruction (e.g., raptor cliffs); water level or water quality fluctuations.

Hanley, P.T., J.E. Hemming, J.W. Morsell, T.A. Morehouse, L.E. Leask, and G.S. Harrison. 1981. Natural resource protection and petroleum development in Alaska. USFWS, Office of Biol. Services, Washington, D.C. August. 306 pp. (ADF&G-A)*

In this review and discussion article, the effects of petroleum development on moose, black and brown bear, arctic and red fox, and wolf of all life stages on Alaska's North Slope, along the trans-Alaska pipeline, in the Cook Inlet area, and on the Kenai Peninsula are considered. The field studies upon which the article is based were performed at all seasons of the year at various times between 1944 and 1981. Habitat types range from arctic tundra on the North Slope to boreal forest on the Kenai Peninsula, including most habitat types in Alaska along the trans-Alaska pipeline. Effects on caribou, fish, and waterfowl of all life stages are also discussed. Documented impacts to fish and wildlife are few, as the article concentrates on physical alterations in the environment that may cause impacts to fish or wildlife. Mitigation guidelines are given but are not based on documented impacts.

Moose. The activity of transporting oil by land was responsible for the documented direct impact of barrier to movement. Conclusive results showed that moose passed under pipe at heights of 1.8-2.4 m (6-8 ft) more frequently than at other heights. The activity of transporting personnel/equipment/- material by air was responsible for the potential direct impact of passive harassment. Conclusive results showed that overflights at altitudes of 305 m (1000 ft) or less during low cloud conditions, did not result in harassment of moose along the Colville River.

Bear. The activities of drilling and or transporting oil by land were responsible for the documented direct impact of attraction to an artificial food source. Conclusive results showed that brown bears were attracted to garbage in drilling camps in the NPR-A and that brown and black bears were attracted to construction camps and construction areas for the trans-Alaska pipeline. The activity of blasting was responsible for the documented direct impact of passive harassment. Brown bears within 2 km (1.25 mi) of winter seismic blasting in NPR-A conclusively moved their dens as a result of the blasts.

Arctic fox and wolf. The activities of drilling and of transporting oil by land were responsible for the direct documented impact of attraction to an artificial food source. Arctic foxes were attracted to construction camps for the trans-Alaska pipeline, and higher populations thrive in the Prudhoe Bay area than prior to development, because of feeding by humans and on garbage. Both wolves and foxes were attracted to NPR-A drilling camps.

Activity: transport of oil/gas/water - land.

Impact: attraction to artificial food source.

Jepson, R., R.G. Taylor, and D.W. McKenzie. 1983. Rangeland fencing systems state-of-the-art review. USDA:Forest Service Equipment Development Center. Project Record 8322 1201. 2200 Range. San Dimas, CA. Oct. 23 pp. (ADF&G-F)*

In this review paper, the effects of fencing on deer of all life stages are mentioned, and fences that will block deer movements or allow deer to pass through are described. Fences that block or direct coyotes of all life stages are also mentioned. Coyotes are found in Alaska, and Sitka black-tailed deer are sufficiently closely related to deer found in other areas of the Unites States that their behavior toward fences is expected to be similar. The studies cited were done in several areas at latitudes south of Alaska and in habitat types usually dissimilar to the temperate coastal wet coniferous forests of Southeast Alaska, but responses of deer and coyotes to fences are expected to be independent of habitat type. The dated studies and technical guides cited were published between 1962 and 1982, and many others were not dated. For deer, the activity of fencing was responsible for the documented direct impacts of barriers to movement and of entanglement. For coyotes, the activity of grazing of domestic sheep was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Recommendations for fencing designs are made. For coyotes, these are the same as those made in Gates 1978 and deLorenzo 1977, with additional data that the number of wires in the electric fence described in Gates 1978 has been decreased from 12 to 5 or 9 wires in areas such as Oregon, where coyote densities are low, with only a slight (5%) increase in coyote predation. Twelve wires are still recommended in areas of high coyote densities. Electroplastic netting also effectively excludes coyotes from domestic sheep, as well as contains sheep. Deer deterrent fences are essentially the same as the outrigger type described in USDA Forest Service 1978 and the 2.1 to 2.6 m (7 to 8½ ft) tall wire fences described in USDA/SCS 1979, USDA Forest Service 1978, and Rasmusson 1985. The outrigger type is easily damaged by livestock and will become useless as shrubs grow beneath it. In heavy snowpack areas, the tall net wire fence with posts 4.6 m (15 ft) apart requires high maintenance. The alternative design for such areas is a 2.4 m (8 ft) high 14-strand barbed wire fence with posts 3.7 m (12 ft) apart and with three-wire stays between posts. Three modifications are recommended for standard livestock fences to allow deer to pass more freely: limit fence height to 102 to 107 cm (40 to 42 in), use let-down fencing, and use smooth wire for the top two wires to avoid interlocking of barbs if a deer catches a hind leg, or place the top two wires 30 cm (12 in) apart. No single useful reference source on fencing considerations for wildlife was found by the authors.

Activity: fencing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Joyce, M.R. 1980. Effects of gravel removal on terrestrial biota. Pages 215-272 in Woodward-Clyde Consultants, Gravel removal studies in arctic and subarctic floodplains in Alaska. Tech. rept., Biological Services Program, U.S. Environemtnal Protection Agency and USFWS. FWS/OBS-80.08 Washington, D.C. 403 pp.

In this field research report, the effects of gravel removal from floodplains in interior, arctic, and western Alaska on terrestrial wildlife, including moose, beaver, muskrat, and arctic ground squirrel of all life stages, were studied. Twenty-five sites were examined 2 to 20 yr after disturbance during the summers between spring 1976 and March 1979, and seven of those were also visited during the winters of 1977-1978 and 1978-1979. Habitat types include riparian forests of white spruce and balsam poplar, tall and low shrub stands, and herbaceous or sparse woody plant stands, or bare river bars in the arctic floodplain. Removal of gravel was responsible for the documented indirect impacts of terrain alteration or destruction, vegetation removal, and water level flucuations. Conclusive results were that significant amounts of dense riparian shrub thickets that provide critical feeding and cover habitats for moose during winter were removed from five sites. Moose most likely responded by increased reliance on adjacent undisturbed thickets or by shifts in winter distribution. Scraping of gravel to a level at or below the average height of summer flows at inside bends or immediately adjacent to or within the active channel resulted in long-term terrestrial habitat loss because of permanent flooding or river hydraulic changes leading to annual flooding, shifted channels, or aufeis accumulation. Under circumstances in which the above problems did not occur, natural revegetation was under way in about 10 yr and was hastened by the presence of overburden piles, woody slash and debris, displaced organic mats, or an abundant seed source in the mined area. At several sites with overburden piles, arctic ground squirrels were more abundant than in adjacent unmined areas. Beaver and muskrat utilized ponded areas in some mined sites along interior rivers. Mitigative guidelines are as follows: 1) whenever possible, avoid vegetated habitats; 2) when scraping in active or inactive floodplains, maintain buffers that will contain active channels to their original locations and configurations; 3) when small quanitities are required (approximately 50,000 m^3 or 65,350 yd^3), select sites that will scrape only unvegetated gravel deposits; 4) when large quantitites are required (approximately in excess of 50,000 m^3 or 65,350 yd^3), select large rivers containing sufficient gravel in unvegetated areas, or select terrace locations on the inactive side of the floodplain and mine by pit excavation; 5) if pit mining, design a configuration with high shoreline and water depth diversity and provide islands; and 6) if mining in vegetated areas, save all overburden and vegetative slash and debris to use during site rehabilitation to facilitate vegetative recovery. This material should be piled or broadcast in such a manner that it will not be washed downstream.

Activity: dredging; filling and pile-supported structures (aquatic).

Impact: aquatic substrate materials, addition or removal; aquatic vegetation, destruction or change in composition; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Joyce, M.R., L.A. Rundquist, L.L. Moulton, R.W. Firth, Jr., and E.H. Follman. 1980. Gravel removal guidelines manual for arctic and subarctic floodplains. USFWS by Woodward-Clyde Consultants. Office of Biological Services, USDI. Wash., D.C. 169 pp. (UAF)*

In this guidelines manual based on field research studies in floodplains of interior, arctic, and western Alaska, mitigation guidelines for the indirect impacts of gravel removal (terrain alteration or destruction, vegetation removal, and water quality fluctuations) on moose, arctic ground squirrels, beavers, and muskrats are presented in detail. Refer to Joyce 1980 for a summary of the guidelines and for the data upon which they are based.

Activity: dredging; filling and pile-supported structures (aquatic).

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

This review article discusses the interactions between agriculture and wildlife, including bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the contiguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level, and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine, during white settlement, are attributed to overharvest and in some cases habitat destruction. In the contiguous 40 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain-growing areas in Alaska, in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms, and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: clearing and tree harvest; grading/plowing; grazing.

Impact: attraction to artificial food source; harvest, change in level; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Klein, D.R. 1973. The reaction of some northern mammals to aircraft disturbance. Pages 377-383 in The eleventh international congress of game biologists, Stockholm, Sweden. (UAF)

In this field research paper, reactions of caribou, moose, brown bear, and wolf of all life stages occurring in summer to low altitude aircraft were made during May through July 1973 in northeastern Alaska. The habitat type was arctic tundra. The activity of transport of personnel, equipment, or material by air was responsible for the documented direct impacts of active and passive harassment. Although this is a preliminary report of a study in progress and most of the observations were made on caribou (see separate annotation), tentative results are reported for the other species. Moose were usually indifferent to the single engine fixed-wing aircraft and helicopter, and those which ran were generally cows with young calves. Brown bears reacted very strongly, running at a distance for cover or sharply away from the flight path. Wolves were disturbed very little, contrary to the extreme alarm the populations had shown until four years previous, when aerial hunting was banned. Distances are not stated. Animal populations had been habituated to 15-20 overflights annually, prior to the study.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Klein, D.R. 1979. The Alaska oil pipeline in retrospect. Trans. N. Am. Wildl. Nat. Resource Conf. 44:235-246. (GD)#

Caribou have not adjusted as well as moose to the presence of the trans-Alaska pipeline. Research has shown that caribou have altered their movements and patterns of range use in relation to the pipeline corridor. Cows with calves show pronounced avoidance of the pipeline, road, and oilfield. Traffic and human activity appear more directly responsible for avoidance behavior than does the physical presence of the pipeline, road, and facilities. Animals along the haul road are especially vulnerable to poaching because of the open terrain and the fact that many became tame during the peak of construction activity. Poaching, especially of furbearers, has increased as pipeline- related traffic has decreased.

Activity: transport of oil/gas/water - land; transport of personnel/equipment/material - land.

Impact: harvest, change in level.

Lokemoen, J.T., H.A. Doty, D.E. Sharp, and J.E. Neaville. 1982. Electric fences to reduce mammalian predation on waterfowl nests. Wildl. Soc. Bull. 10:318-323.

This field research paper discusses electric fences that inhibited the movement of red foxes of all life stages, among other small carnivores, in the prairie pothole region of eastern North Dakota and western Minnesota. The studies were started in April or early May and completed in July of the years 1978 through 1981. Although the study areas are at a more southerly latitude than Alaska and the habitat types of fields of small grains, pastures, or row crops, interspersed with wetlands, lakes, and woodlots are not comparable to those in most of Alaska, the responses of red foxes to fences in Alaska would be expected to be similar. The activity of fencing was responsible for the documented direct impact of barriers to movement. Conclusive results showed that a seven-strand high-tensile smooth-wire electric fence significantly decreased predation of waterfowl nests within the exclosure by red foxes, among other small carnivores, although it did not totally exclude these predators. The 12.5-ga wires were strung at 10, 20, 36, 56, 76, 102, and 127 cm (4, 8, 14, 22, 30, 40, and 50 in) above ground level. Wires 1, 2, 3, 5, and 7 above ground level were charged, and wires 4 and 6 were grounded. The soil was sterilized along a 2 m (6.6 ft) wide strip of ground centered on the fence to prevent vegetation growth from shorting out the fence. Other aspects of fence construction were the same as described in Jepson et al. 1983.

Activity: fencing.

Impact: barriers to movement, physical and behavioral.

Milke, G. 1977. Animal feeding: problems and solutions. Joint State/Fed. Fish and Wildl. Advisory Team Spec. Rept. No. 14. 11 pp. (UAF)*

This paper reviews the problem of animal feeding that occurred during construction of the Trans-Alaska Pipeline System during the period 1974 through 1977. Grizzly bears, black bears, wolves, red and arctic foxes, gulls, ravens, and ground squirrels are discussed. Habitat within the area of concern included arctic, shrub, and alpine tundra, open and closed coniferous forest, and riparian habitat. The activities of transporting of oil/gas/water by land, transporting of personnel/equipment/material by air and land, grading and plowing, solid waste disposal, and human disturbance produced documented direct impacts of active and passive harassment, attraction to an artificial food source, collision with vehicles, and change in level of harvest. Bears, wolves, and foxes were attracted to improperly stored food and garbage at construction camps and pump stations and to handouts from workers at camps and worksites. Bears and wolves were harassed by helicopters, vehicles, and guns in attempts to drive them away from camps and worksites. Problem animals, particularly bears, were occasionally killed. Additional animals were also killed by some workers in more remote areas. Emetics were given, with mixed results, to some animals to stimulate an avoidance response. Recommendations included 1) education of workers to discourage feeding of animals, 2) incineration of edible garbage, 3) immediate removal of litter and garbage from worksites, 4) storage of food or garbage in buildings or animal-proof containers, and 5) fencing of all construction camps and dumps.

Activity: human disturbance; solid waste disposal; transport of oil/gas/water - land; transport of personnel/equipment/material air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level.

Peller, E. 1963. Operation duck rescue. Audubon Magazine 65:364-367. (UAF)

This article describes the entrapment and death of beavers, muskrats, and several species of ducks and seabirds of all life stages in an oil spill on the Mississippi River in Minnesota in early April of 1963. The ducks and seabirds were migrating north and are the same species that occur in Alaska. Although the geographic area is south of the latitude of Alaska, the habitat types of riparian areas, sloughs, and small lakes are comparable to those along rivers in Alaska, and the effects of oil spills are expected to be similar. The activity of transporting oil/gas/water by land was responsible for the documented direct impacts of morbidity and mortality due to contact with petroleum and water quality fluctuations. Soybean oil from a ruptured tank and crude oil from a broken pipe had poured into the Minnesota River in December 1962 and January 1963 and flowed about 160 km (100 mi) into the Mississippi River during breakup. It accumulated in resting and feeding areas for migrating waterfowl and in beaver and muskrat habitat and killed over 10,000 birds and furbearers. One deer was seen covered with oil, but morbidity or mortality of deer was not documented. Oiled birds were washed, but attempts to contain the oil with log booms or to disperse it with emulsifiers were not successful.

Activity: transport of oil/gas/water - land.

Impact: morbidity or mortality due to ingestion of or contact with petroleum; water level or water quality fluctuations.

Preston, D.J. 1983b. The impacts of agriculture on wildlife. ADF&G, Fed. Aid in Wildl. Rest. Final rept. (Research) Projs. W-21-2 and W-22-1, Job 18.6R. Juneau. 143 pp. (ADF&G-F)*

In this review paper, the effects of agriculture on all life stages of a variety of wildlife species throughout North America are discussed. The following wildlife species and species groups featured in the Alaska Habitat Management Guide are included: swans, geese, ducks, several furbearers, brown bears, deer, moose, caribou, mountain goats, and Dall sheep. These species either occur in Alaska or are closely related to Alaskan species and are expected to respond similarly to agricultural activities. The 1,200 references cited range throughout the geographic areas and habitat types of North America. In most cases, the overall impacts of agriculture are independent of the specific location in which they were documented. The original studies were done throughout all seasons over the past several decades and were published primarily after 1970. Most of the impacts are discussed in terms of major wildlife species groups (e.g., birds, ungulates) and are not applicable to the species approach used in the AHMG. The few impacts identified as affecting moose, mountain sheep, and furbearers are summarized by species, followed by mitigation guidelines suggested for those impacts.

Moose. The activities of clearing and tree harvest and grading and plowing were responsible for the documented indirect impact of vegetation composition change, and the activity of grading and plowing was responsible for the documented direct impact of attraction to an artificial food source. Conclusive results were that 1,200-2,000 ha (3,000-4,000 ac) of good moose winter range were lost to the Delta agricultural project. Cultivated land is used less than other habitat types. Moose are attracted to gardens, especially in rural areas of Alaska. Mitigation recommendations are to protect crops by means of fencing designed to minimize entanglement of moose and by other nonlethal methods.

Sheep. The activity of grazing has been responsible for the documented direct impact of competition with or disease transmission from domestic species. Impacts were documented on bighorn sheep only, but effects on Dall sheep are expected to be similar. Livestock compete with bighorns for forage, and domestic sheep have transmitted three lethal diseases to bighorns: scabies mites, bluetongue virus (sampled for and found not to be present in Alaskan wildlife), and parainfluenza-3 virus (which causes pneumonia). The mitigation recommendation is to prohibit grazing livestock in or near (no distance stated) Dall sheep range.

Furbearers. The activities of grading and plowing and grazing were responsible for the documented direct impact of attraction to artificial food sources. The activity of fencing was responsible for the documented direct impact of barriers to movement and that of chemical application for the documented direct impact of mortality due to ingestion of chemicals. Squirrels are attracted to gardens, coyotes to domestic sheep, calves, and poultry, and wolves to sheep, calves and yearlings, and horses. Coyotes are

poisoned by chemical traps and by toxic collars on domestic sheep and are kept out of flocks of domestic sheep by deterrent, directing, or electric fences. Mitigation recommendations include restricting calving and lambing to easily monitored areas and disposing of livestock carcasses properly.

Deer. The activity of grading/plowing (growing crops) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. The activity of grazing was responsible for the documented direct impact of disease transmission from introduced domestic species. These impacts were documented on white-tailed and black-tailed deer, and effects on Sitka black-tailed deer are expected to be similar. Five strand high-tensile electric fencing successfully prevented deer that had been attracted to crops from entering fields or orchards and was not prohibitively expensive. Lethal epizootics of foot and mouth disease, bluetongue, and epizootic hemorrhagic disease have spread through deer populations in the contiguous 48 states after livestock transmitted the diseases to deer. Deer in Florida have also been infested by the cattle fever tick. In two documented cases, tens of thousands of deer were slaughtered to prevent reinfection of livestock. Recommendations are to actively implement existing disease regulations pertaining to importing livestock into Alaska and to monitor wildlife populations for exposure to livestock pathogens. Regulations require that imported livestock be free from disease.

Mountain goat. No impacts on mountain goats were documented in this paper.

An extensive subject index, including a taxonomic index to wildlife species, directs the reader to the references cited. Numerous other mitigation recommendations are made but are not directly supported by impacts documented on a stated wildlife species.

[Reviewer's note: This is an excellent, thorough review of the agricultural impact literature within and outside of Alaska. Not all references are applicable to Alaska, and impacts are not all documented in the sense used in the AHMG.]

Activity: chemical application; fencing; grading/plowing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; morbidity or mortality due to ingestion of or contact with petroleum.

Reynolds, P.C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks on the Brooks Range, Alaska. Chapter 2 in R.D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser., Vol. 23. 82 pp. August. (ADF&G-F)*

The response of Dall sheep at mineral licks and of red fox in alpine tundra habitat along the Marsh Fork of the Canning River, eastern Brooks Range, Alaska, to simulated compressor station noise was tested during late July and early August of 1972. This field research article summarizes the results. The activities of transporting oil/gas/water by land and transporting personnel/equipment/material by air were responsible for the direct, documented impact of passive harassment. Conclusive results of control and noise exposure test periods showed no change in use of either of two licks, 0.4 and 1.2 km (0.25 and 0.75 mi) from the simulator, by all ages and sexes of sheep. Sheep did spend less time in the part of each lick exposed to the highest sound levels. The weather was cold, with mixed snow and rain, during the control periods and sunny and 20°F warmer during the noise simulation period. The author accounts for the apparent contradiction between these results and those of McCourt et al. (1974) as being due to two factors: 1) preconditioning in this study only by an average of three fixed-wing or helicopter flights daily along the river for the previous two months; and 2) mineral licks are a point resource presumably fulfilling a physiological need, while summer range (in McCourt et al.) is more widely distributed. Reactions to aircraft were also noted in Reynolds' study, with the conclusive result that sheep showed strong reactions (running) to helicopters within 137 m (150 yd) but little or no reaction to aircraft 0.4-1.2 km (0.25-0.75 mi). Caution is recommended in selecting compressor station sites due to the possible compounding impacts of the variety of activities associated with such facilities and not examined in this study.

A red fox den containing four pups located 1.6 km (1 mi) from the simulator remained occupied, but the foxes did not hunt between the den and the simulator during the experimental phase. The importance of acute hearing for hunting is cited as a cause of this passive harassment.

[Reviewer's note: Although the author does not consider the weather difference important, sheep use of licks is higher during good weather, and weather probably confounded the experimental results.]

Activity: transport of oil/gas/water - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Ruttan, R.A. 1974. Arctic fox on the north slope of the Yukon Territory, 1972. Chapter 1 in R.A. Ruttan, and D.R. Wooley, eds. Studies of furbearers associated with proposed pipeline routes in the Yukon and Northwest Territories. Arctic Gas Biol. Rept. Ser., Vol. 9. (UAF)*

In this summary of field research on the wet tundra of the coastal plains, foothills, and deltas of the north slope of the Yukon Territory in 1972, observations were made on the responses of arctic foxes to the impacts of active and passive harassment associated with the activities of human disturbance and transporting personnel/equipment/material by air. Arctic foxes do not occur in the Southcentral Region, but colored foxes in subalpine or tundra areas would be expected to exhibit similar responses. Documented reactions of adult foxes at dens to single or multiple observers were slight (observation and alterness) to human(s) in full view at distances greater than 152 m (500 ft). Between 152 and 38 m (500 and 125 ft), foxes exhibited disturbed behavior, including pacing, urinating, and going into and out of burrows. At distances less than 38 m (125 ft), most foxes remained in their burrows. Very young pups were more curious and less disturbed, while older pups behaved similarly to adults. Most adult foxes were watchfully curious when a helicopter flew over at an altitude of 305 m (1,000 ft), but one dodged and ran. The activity of transporting personnel/equipment/material by land resulted in the documented impact of terrain destruction, as a Nodwell collapsed a den, rendering it unusable.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); terrain alteration or destruction (e.g., raptor cliffs).

Ruttan, R.A., and D.R. Wooley. 1974. A study of furbearers associated with proposed pipeline routes in the Yukon Territory and Mackenzie River valley, 1971. Arctic Gas Biol. Rept. Ser., Vol. 8. 118 pp. plus photos. (UAF)

All furbearers occurring in Alaska, with the exception of coyote, are discussed in this field research paper. Moose are also discussed. Field studies were conducted from June through November 1971 in arctic tundra and boreal forest habitat types in the Yukon Territory and Mackenzie River valley. Latitudes and habitat types are similar to those in Alaska, excepting Southeast and the Alaska Pennisula, where maritime influence predominates.

Furbearers. The activity of mechanical clearing leads to the potential direct impact of barriers to movement. Conclusive results of this study show the contrary, that fox, lynx, wolf, and wolverine often travel and forage along seismic lines and that marten and weasels cross them without hesitation. Documented indirect impacts include 1) alteration of the prey base, as ptarmigan were observed to favor open areas of seismic lines, especially where willows were regenerating; and 2) vegetation damage/destruction by mechanical removal and subsequent thermal erosion. Conclusive results show that in all but sphagnum bog and erosion areas natural revegetation was rapid. There was no significant difference in small mammal populations (food for carnivorous furbearers) between a disturbed and regenerated and an undisturbed area. Beavers established a pond where a seismic line crosses a creek. Also discussed in this paper are furbearer populations and habitat quality and impacts on human use of furbearers.

Moose. Along with other large mammals, moose were observed to use seismic lines for foraging and travel during summer and in winter under shallow snow conditions.

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sigman, M.J., ed. 1985. Impacts of clearcut logging on the fish and wildlife resources of Southeast Alaska. ADF&G, Div. Habitat, Tech. Rept. 85-3. 95 pp. Juneau. (ADF&G-F)*

This review article discusses the effects of clear-cut logging on Sitka black-tailed deer, mountain goat, moose, brown and black bear, Bald Eagle, marten, mink, land otter, and red squirrel of all life stages, among other species. Most of the papers cited describe research done in Southeast Alaska since 1970, but older publications and studies performed on the same species in other geographic areas where the habitat types and latitude are similar to those of Southeast Alaska are also included. The studies were done at all seasons of the year. The habitat type is coastal temperate rain forest dominated by Sitka spruce, western hemlock, and other conifers. In addition to documented impacts, potential impacts are discussed, and life history and habitat use information is presented for each wildlife species. Only documented impacts and recommendations made in the cited papers are summarized below by species. Management recommendations made by the author are generalizations of those made in the cited papers and are not repeated here.

Sitka black-tailed deer. The activity of clearing and tree harvest was responsible for the documented direct impact of barriers to movement and for the documented indirect impacts of vegetation composition change to less preferred successional stage and vegetation damage or destruction due to mechanical removal. Dense shrubs and slash in clear-cuts less than 15 to 40 years old precludes deer movement and use in summer, and in winter higher snow depths in clear-cuts nearly prevent deer use and movement. Even in winters of little snow accumulation and in summer, deer avoid clear-cuts and prefer mature old-growth forest habitats. Precommercial thinning may prolong understory production in stands prior to canopy closure, but any effect is short-lived and a two-layered conifer stand results. Deer populations have declined by 50 to 75% after clear-cutting of areas on and near Vancouver Island, B.C. Mitigation recommendations are to burn slash or clear trails through it for deer, to cease disproportionate harvest of high-volume old-growth timber, and to avoid harvesting old-growth stands with exceptional fish and wildlife values.

Mountain goat. The activities of clearing and tree harvest and human disturbance were responsible for the documented direct impact of harassment. The activities of grading/plowing (road construction) and transporting personnel/equipment/material by land were responsible for the documented direct impacts of barriers to movement, harassment, and change in harvest level. Logging, logging camps and associated human noise, and vehicle traffic disturb goat behavior and cause abandonment of preferred high-quality summer range within and near the disturbances. The effects from logging camps have been documented within a 2 km (1.25 mi) radius and include increased mortality of goats. Construction of new roads has blocked goat movement and led to overharvest of previously less accessable populations. No recommendations based on documented impacts were made.

Moose. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. Although the high amount of forage in recent clear-cuts is beneficial to moose in areas of Southeast Alaska where riparian foreage is not abundant, as clear-cuts become dominated by young conifers moose cease using them. During periods of deep snow, moose do not use even recent clear-cuts but feed in high-volume old-growth and river terrace forests and in riparian shrub stands. Mitigation recommendations are to retain forests around and within high-density feeding, breeding, and movement areas, and to retain any old growth river terrace forests or any other old-growth forest types that are limited in extent in the area of concern, as well as a portion of old-growth forests even if they are not limited in extent.

Furbearers. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. No impacts on wolves were documented, only on an important prey species included in the AHMG, Sitka black-tailed deer (q.v.). Populations of marten decline when mature coniferous forests are clear-cut, due to greatly decreased populations of red-backed voles, an important prey species, and due to loss of den sites in hollow trees and deadfalls. In winter, marten do not hunt in clear-cuts but only in dense, mature coniferous forest stands. They will cross but will not hunt in openings greater than 91 m (300 ft) in width. No mitigation recommendations were made for marten. Mink made almost no use of clear-cuts. Mitigation recommendations are to retain windfirm shoreline buffer strips at least 60 m (197 ft) inland from the shoreline. If shoreline forests must be clear-cut, keep the length of shoreline cut as short as possible, never more than 0.8 km (0.5 mi), and avoid cutting shoreline timber on points and in other areas where narrow timber stands separate shorelines, along intertidal zones where the distance between the 0 and +6 m (+20 ft) lines are less than 40 m (131 ft) apart, and along intertidal areas with high exposure of bedrock and boulder cover. Land otters avoid using clear-cuts for travel, burrows, or natal dens. Mitigation recommendations are to avoid logging adjacent to watercourses from early May to late summer (the breeding season) and to retain a windfirm fringe of forest 50 to 75 m (164 to 246 ft) wide along the beach to meet otter habitat requirements. Denning and feeding areas for red squirrels are eliminated by clear-cutting. Red squirrels cannot utilize clear-cuts until cone production by revegetating conifers is reestablished after 20 to 40 yr.

Brown bear. References reviewed for impacts to brown bear included studies conducted in coastal forests and studies conducted in interior forests (e.g., Montana). The activity of clearing and tree harvest produced documented impacts of changes in vegetation composition to less preferred successional stages (e.g., changing old growth to even aged forest), vegetation damage and destruction due to mechanical removal, barriers to movements (e.g., extensive areas of slash), and harassment. The activity of grading (road building) produced a documented direct impact of harassment.

The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source (i.e., garbage). The activity of human disturbance produced documented direct impacts of harassment and an increase in the harvest of bears (nuisance kills and increased access for hunters).

Bald Eagle. The activity of clearing and tree harvest produced a documented indirect impact of vegetation damage/destruction due to mechanical removal. Logging within 45 m (150 ft) of nest trees resulted in blowdown of nest trees at a rate 20 times more common than when logging occurred further than 45 m (150 ft) from the nest trees.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Simpson, P.W., J.R. Newman, M.A. Mather, and P.A. Guthrie. 1982. Manual of stream channelization impacts on fish and wildlife. FWS/OBS-82/24. 155 pp. (HD)#

This manual contains a synthesis of the diverse literature dealing with the effects of stream channelization, allowing the reader to develop an understanding of channelization impacts on fish and wildlife resources associated with such streams. Major topics include: 1) regulatory history of stream channelization, 2) structural, physical, and chemical impacts of channelization, and 3) biological impacts of channelization. Information is summarized to provide the user with an overview and general understanding as well as analysis of key studies of the impacts of channelization.

The effects of channelization include: 1) loss of woody vegetation, 2) changes in bank composition and configuration, 3) low water levels, 4) reduction of channel snags and debris, and 5) reduction or loss of aquatic organisms. Alteration of the bank shortens the available bank for burrows or dens and reduces the foraging area for beaver. Construction of berms to replace the natural bank reduced denning opportunities due to deposition of sand and gravel on the berm. Loss of vegetation along the channel reduced available cover and food sources for beaver.

Large mammals such as deer are very mobile with large ranges and therefore, are less likely to be affected by impacts of channelization. Several researchers found deer using channelized sites and could find no significant differences between channelized and unchannelized sites.

Channelization may reduce the value of riparian systems as travel lanes for deer, especially in agriculture or non-wooded areas. The corridor effect of channelization influences human accessibility and hunting success rates for big game animals.

Activity: channelizing waterways.

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Slough, B.G., and R.M.F.S. Sadlier. 1977. A land capability classification system for beaver (*Castor canadensis* Kuhl). Can. J. Zool. 55:1,324-1,335. (GD)#

Beaver colony site density was sampled on 136 lakes (about 1,830 shoreline km, 1,144 mi) and 45 steam sections (145 stream km, 91 mi) in the northern interior of British Columbia. Beaver habitat factors were quantified and then related to beaver colony site density by multiple regression analysis. On the basis of separate analyses for lakes and streams, a land-capability classification system was developed for beaver. The regression equations are also useful as models of beaver-habitat relationships and can be used for beaver inventory by prediction of beaver colony site density.

Food availability and water stability are the most important factors influencing the use of freshwater aquatic habitats by beaver. Roads, railways, and land clearing activities are major limiting factors to beaver habitat suitability. Artificial water regulation by hydroelectric dams and the removal of beaver dams can produce severe fluctuations.

Activity: clearing and tree harvest; transport of personnel/equipment/ material - land; water regulation/withdrawal/irrigation.

Impact: aquatic vegetation, destruction or change in composition; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: blasting; burning; clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land; water regulation/withdrawal/irrigation.

Impact: aquatic substrate materials, addition or removal; aquatic vegetation, destruction or change in composition; attraction to artificial food source; barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; parasitism and predation, increased susceptibility to; prey base, alteration of; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Stephenson, R.O. 1984. The relationship of fire history to furbearer populations and harvest. ADF&G, Fed. Aid in Wildl. Rest. final rept. (research). Proj. W-22-2, Job 7.13R. Juneau. 86 pp. (ADF&G-F)*

In this paper, which summarizes information gained by interviews of trappers in interior Alaska between July 1982 and June 1983, the effects of fire on all furbearer species present in the interior are described, with emphasis on lynx, marten, red fox, and beaver of all ages and both sexes. Effects on birds of prey and moose are also mentioned. Habitat types included taiga vegetation, including spruce and hardwood forests, bogs, brush thickets, grasslands, sedge meadows, and alpine tundra. Areas not recently burned and burns from 2 to 80 years of age were included. The activity of burning was responsible for indirect documented impacts of alteration of prey base, vegetation composition change, and vegetation damage/destruction due to fire. Burns were perceived as beneficial in the short term (1-10 years) for most furbearers, with greater benefits in areas of most frequent fire occurrence. High postburn densities of voles provide food for marten, red fox, ermine, mink, and birds of prey. Productive beaver habitat develops within 10 yr, and good lynx habitat does so at about 15 yr postburn. Wolves benefit from moose attracted by vegetative regrowth. Only for red squirrel does a persistent negative fire effect occur. Effects on other than furbearers were minor or could not be determined. Some fires, however, create generally poor furbearer habitat that persists for relatively long periods. The effects of fire in treeline habitat, which regenerates slowly, may differ from those described in this paper.

Activity: burning.

Impact: vegetation damage/destruction due to fire or induced parasitism.

Tracy, D.M. 1977. Reactions of wildlife to human activity along Mount McKinley National Park Road. M.S. Thesis, Univ. Alaska, Fairbanks. xxii + 260 pp. (UAF)*

In this thesis based on field research, moose, Dall sheep, and several furbearers, including red fox, wolf, and lynx, at all life stages and of both sexes were observed during mid May through September of 1973 and 1974 along and adjacent to the road through Mount McKinley National Park. Habitat types include subalpine white spruce forests, tall and low shrub stands, alpine tundra, and wetland and riparian vegetation. The activities of human disturbance and transport of personnel/equipment/material by land were responsible for direct, documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, active and passive harassment, interference with reproductive behavior, alteration of prey base, and vegetation composition change.

Moose. Conclusive results showed that moose did not avoid watersheds traversed by the road. At distances greater than 300 m (984 ft) from the road, moose rarely reacted to human disturbance along the road. At distances less than 200 m (656 ft), loud noises and people quietly getting off busses increased passive harassment by two to three times. Young calves stumbled or rolled down a bank when surprised by hikers or vehicles. Habituation of some moose to moderate disturbances occurred over the course of the summers. Although at distances of less than 200 m (656 ft) only half of the moose showed visible responses to road disturbance, responses such as staring then slowly moving into cover while browsing were not recorded. Willows revegetating cleared roadsides may occasionally attract moose, and one moose was killed by a vehicle collision during this study.

Dall Sheep. Conclusive results show that Dall sheep became habituated to photographers, allowing approaches on foot to within 100 m (328 ft). Some sheep have become habituated to crossing the road between summer and winter range in the presence of people and vehicles, while the movements of others are inhibited by the road. Within 200 m (656 ft) of the road, 32% of sheep showed strong responses to buses and visitors, while no strong responses were noted beyond 400 m (1,312 ft). The percentage of strong responses within 200 m (656 ft) increased from busses passing through to busses stopping to people getting out, and was greatly increased by loud noises. Tentatively, since use of the range where the road runs through sheep habitat was much greater in the past, disturbance may have resulted in abandonment of the range by most sheep.

Furbearers. Conclusive results showed that red fox also did not avoid the vicinity of the road, for hunting or denning. Foxes more than 100 m (328 ft) from the road rarely responded strongly to disturbance, but mild responses were observed to 600 m (1,968 ft). Habituation to disturbance readily occurs. Foxes hunt and travel along the road, and are sometimes fed by visitors.

Wolves use the road for travel, especially in winter when it is closed, scavenge road kills, and become beggars when fed by visitors. Wolves are infrequently strongly disturbed while killing or feeding within 200 m (656 ft) of the road.

Lynx, on the three occasions sighted, showed only mild reactions to vehicles on the road 200 m (656 ft) away and to a quiet human 100 m (328 ft) away.

Hares, prey for several furbearers, were attracted to roadside artificial and natural revegetation, the latter in early spring and the former during the summer. A man-made mineral lick along the road also attracted hares.

> Activity: human disturbance; transport of personnel/equipment/material - land.
>
> Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent); prey base, alteration of.

USDI. 1976a. Alaska natural gas transportation system - final environmental impact statement. Washington, D.C. (ARL)#*

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.
2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.
3) Muskoxen may have shifted their traditional summer range by 25.6 km (16 mi) in response to heavy helicopter traffic.
4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.
5) Muskoxen and Canadian geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.
2) Caribou can apparently tolerate winter blasting if they are not hunted.
3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.
4) Waterfowl with young avoid drilling rigs within a 4.3 km (2-2/3 mi) radius.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Vinogradov, V.V., and S.I. Chernyavskoya. 1976. Changes in the habitat conditions of animals in the Volga Delta associated with the implementation of the Volgograd hydroelectric station. Byull Mosk. O-Va. Ispyt. Prir. Otd. Biol. 81(1):136-138. #(Library not stated in Southwest citation).

In this article, various animal species in the Volga Delta, USSR, are discussed. The animal species and life stages, dates of study, type of study, and most habitat types involved were not stated in the Southwest Guide annotation. The activity of water regulation/withdrawal by the Volgograd dam, completed in 1958, resulted in indirect, documented impacts of vegetation composition change to less preferred or useable species and water level or water quality fluctuations. Vastly reduced alluvial deposits slowed the formation of new islands and spits, which had previously become vegetated by highly productive white willow associations. After 20 years, the reproducing ability of the willow declined, and a less productive reed-grass association replaced the willow. Detailed effects on animal species are not mentioned in the Southwest Guide annotation.

Activity: water regulation/withdrawal/irrigation.

Impact: vegetation composition, change to less preferred or useable species; water level or water quality fluctuations.

Yeager, L.E., and R.R. Hills. 1954. Beaver management problems on western public lands. Trans. N. Am. Conf. 19:462-480. (GD)#*

This paper reviews problems on public lands in Colorado, where rapidly increasing beaver populations have been essentially unmanaged. Observed beaver densities on some small headwater streams are as high as 37.5 animals per stream km (60 per mi). In the management of western watershed lands, the beavers' place is governed by population stability, attained by holding numbers to the carrying capability of their range.

Beaver activity, if not regulated, results in loss of cover and subsequent soil displacement, particularly when dams are abandoned. The benefits of optimum beaver numbers are lost in unmanaged areas. In partial contrast to other researchers, the authors have found beaver beneficial to trout and water-frequenting game and fur animals only when numbers are kept within carrying capacity.

Livestock grazing often prevents regeneration of aspen and willow thus reducing beaver occupancy to temporary status. Beavers alone are not solely responsible for abandoned dams and the associated erosion damage. Foraging of beaver, livestock, and big game has eliminated the food supply necessary for continued value of beaver.

Activity: grazing.

Impact: aquatic substrate materials, addition or removal; vegetation damage/destruction due to grazing by domestic or introduced animals; water level or water quality fluctuations.

13. Moose

Table 1. Impacts Associated With Each Activity - Moose

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change			?			?	?			?																				?
Attraction to artificial food source				X	?	X						X													X			X		
Barriers to movement, physical and behavioral		X	?		X	X	?		X			X		?					?						X			X		?
Collision with vehicles or structures																												X		
Entanglement in fishing nets, debris					?				X																					
Entrapment in impoundments or excavations												?										?						X		?
Harassment, active or passive	X		?		X		?	X		?	?	X	?	X	?		?	?	?	?	?	?			?	?	X	X	?	?
Harvest, change in level		X			X	?	?	X				X						?	?						X			X	X	?
Introduced wild/domestic species, competition													X																	?
Morbidity/mortality by ingestion of petroleum				?				?												?					?	?				
Parasitism/predation, increased susceptibility					?									X																
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction	?	X					X			X	?	?			?							?			?					?
Veg. composition, change to less preferred		X			X	X	X					X	X						?											X
Veg. damage/destruction due to air pollution				X															?	?										
Veg. damage/destruction due to fire/parasitism		X																												
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion		?			X	X	X			X	?	X			?				?			?								
Water level or water quality fluctuations			?			?	X			X			?								?									X

X - Documented impact (see text).
? - Potential impact.

13. MOOSE - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on moose. Each citation refers to an annotation in the following section, Annotated References to Impacts on Moose. Table 1 is a quick index to the impacts and activity for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impacts categories which are not relevant to moose are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to moose were found for the following activities:

Channelizing waterways
Filling (terrestrial)
Log storage/transport
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals
Processing oil/gas
Sewage disposal
Solid waste disposal
Stream crossings - structures
Transport oil/gas/water - water

Activities definitions and the list of impacts categories are located in appendix C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Bangs and Bailey 1982

2. Burning:

   a. Barriers to movement, physical and behavioral

      Davis and Franzmann 1979

b. Harvest, change in level

Davis and Franzmann 1979

c. Terrain alteration or destruction

Davis and Franzmann 1979
Leopold and Darling 1953

d. Veg. composition, change to less preferred

Davis and Franzmann 1979
Irwin 1975
Peek et al. 1976
Sopuck et al. 1979

e. Veg. damage/destruction due to fire/parasitism

Davis and Franzmann 1979
Eastman 1974
Irwin 1975
Leopold and Darling 1953
Preston 1983a
Somerville 1965
Sopuck et al. 1979

3. Chemical application:

a. Attraction to artificial food source

Fraser and Thomas 1982
Grenier 1973
Murie 1934

b. Veg. damage/destruction due to air pollution

Somerville 1965

4. Clearing and tree harvest:

a. Barriers to movement, physical and behavioral

Sopuck et al. 1979

b. Harassment, active or passive

Hancock 1976
Sopuck et al. 1979

Tamm et al. 1981

c. Harvest, change in level

Preston 1983a

d. Veg. composition, change to less preferred

Brusnyk and Gilbert 1983
Crete 1976
Doerr 1983
Doerr et al. 1980
Doerr in press
Elliott 1983
Hamilton and Drysdale 1975
Hunt 1976
Matchett 1984
McNichol and Gilbert 1980
Monthey 1984
Parker and Morton 1978
Peek et al. 1976
Phillips et al. 1973
Preston 1983b
Sigman 1985
Sopuck et al. 1979
Telfer 1974
Tamm et al. 1981

e. Veg. damage/destruction due to erosion

Brusnyk and Gilbert 1983
Crete 1976
Davis and Franzmann 1979
Doerr 1983
Doerr et al. 1980
Doerr in press
EPA 1982
Eastman 1974
Hunt 1976
Klebesadel and Restad 1981
Leopold and Darling 1953
McNichol and Gilbert 1980
Monthey 1984
Phillips et al. 1973
Preston 1983a
Ruttan and Wooley 1974
Sigman 1985
Somerville 1965
Sopuck et al. 1979
Telfer 1974

5. Draining:

    a. Attraction to artificial food source

        Sopuck et al. 1979

    b. Barriers to movement, physical and behavioral

        Phillips et al. 1973

    c. Veg. composition, change to less preferred

        Phillips et al. 1973
        Somerville 1965
        Sopuck et al. 1979

    d. Veg. damage/destruction due to erosion

        Phillips et al. 1973

6. Dredging:

    a. Terrain alteration or destruction

        Joyce 1980
        Joyce et al. 1980

    b. Veg. composition, change to less preferred

        Kertel 1984

    c. Veg. damage/destruction due to erosion

        Joyce 1980
        Joyce et al. 1980

    d. Water level or water quality fluctuations

        Joyce 1980
        Joyce et al. 1980

7. Drilling:

    a. Harassment, active or passive

        Somerville 1965

    b. Harvest, change in level

Lynch 1973

8. Fencing:

   a. Barriers to movement, physical and behavioral

      Burris 1965
      Hauge 1985
      Kinsey 1976
      Preston 1983a

   b. Entanglement in fishing nets, debris

      Preston 1983a

9. Filling and pile-supported structures (aquatic):

   a. Terrain alteration or destruction

      Joyce 1980
      Joyce et al. 1980

   b. Veg. damage/destruction due to erosion

      Joyce 1980
      Joyce et al. 1980

   c. Water level or water quality fluctuations

      Joyce 1980
      Joyce et al. 1980

10. Grading/plowing:

   a. Attraction to artificial food source

      Burris 1965
      Chatelain 1951
      Elliott 1983
      Kinsey 1976
      Preston 1983a
      Preston 1983b

   b. Barriers to movement, physical and behavioral

      Phillips et al. 1973
      Sopuck and Vernam 1984

VanBallenberghe 1978

c. Harassment, active or passive

Mytton and Keith 1981
Sopuck et al. 1979
Tamm et al. 1981

d. Harvest, change in level

Bergerud et al. 1968
Lynch 1973
Preston 1983a

e. Veg. composition, change to less preferred

Elliott 1983
Kertel 1984
Phillips et al. 1973
Preston 1983b
Somerville 1965
Sopuck et al. 1979

f. Veg. damage/destruction due to erosion

EPA 1982
Klebesadel and Restad 1981
Leopold and Darling 1953
Mytton and Keith 1981
Phillips et al. 1973
Preston 1983a
Somerville 1965

11. Grazing:

a. Introduced wild/domestic species, competition

Grauvogel 1984
Holechek et al. 1982

b. Veg. composition, change to less preferred

Knopf and Cannon 1982

c. Veg. damage/destruction due to grazing

Holechek et al. 1982
Knopf and Cannon 1982

12. Human disturbance:

a. Harassment, active or passive

Altmann 1958
Bangs and Bailey 1982
Cobus 1972
DeVos 1958
Doerr 1983
EPA 1982
Ferguson and Keith 1982
Geist 1963
Geist 1971a
Grauvogel 1984
Hancock 1976
LeResche 1966
McMillan 1954
Mould 1977
Murie 1934
Mytton and Keith 1981
Sopuck et al. 1979
Stringham 1971
Tomm et al. 1981
Tracy 1977

b. Parasitism/predation, increased susceptibility

Bangs et al. 1982

13. Transport of oil/gas/water - land, ice:

a. Attraction to artificial food source

Brusnyk and Lunseth 1985

b. Barriers to movement, physical and behavioral

Eide and Miller 1979
Hanley et al. 1981
Sopuck and Vernam 1984
Sopuck et al. 1979
VanBallenberghe 1978

c. Harvest, change in level

Klein 1979

14. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Bangs and Bailey 1982
EPA 1982
Geist 1971b
Hanley et al. 1981
Klein 1973
LeResche 1966
McCourt et al. 1974
Mould 1977
Rausch 1958
Sopuck et al. 1979
USDI 1976a

15. Transport of personnel/equipment/material - land, ice:

a. Attraction to artificial food source

Fraser and Thomas 1982
Sopuck et al. 1979
Tracy 1977

b. Barriers to movement, physical and behavioral

Phillips et al. 1973
Rausch 1958
Sopuck et al. 1979

c. Collision with vehicles or structures

ADF&G 1983
Anonymous 1985a
Anonymous 1985b
Bangs et al. 1982
Chatelain 1951
Child 1983
Foster 1985
Fraser and Thomas 1982
Grenier 1973
Haney 1985
Rausch 1958
Rausch 1965
Somerville 1965
Sopuck et al. 1979
Tracy 1977

d. Entrapment in impoundments or excavations

Rausch 1958

Sopuck et al. 1979

e. Harassment, active or passive

Cobus 1972
EPA 1982
Grauvogel 1984
Hancock 1976
McMillan 1954
Mould 1977
Sopuck et al. 1979
Tomm et al. 1981
Tracy 1977

f. Harvest, change in level

Bergerud et al. 1968
Grauvogel 1984
Klein 1979
Sopuck et al. 1979
Wooley 1976

16. Transport of personnel/equipment/material - water:

a. Harassment, active or passive

EPA 1982
Grauvogel 1984
Hancock 1976

b. Harvest, change in level

Bergerud et al. 1968
Grauvogel 1984

17. Water regulation/withdrawal/irrigation:

a. Veg. composition, change to less preferred

Gill 1973
Vinogradov and Chernyavskoya 1976

b. Water level or water quality fluctuations

Somerville 1965
Vinogradov and Chernyavskoya 1976

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to moose were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Morbidity/mortality by ingestion of petroleum
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Chemical application

      Samuel et al. 1975

   b. Clearing and tree harvest

      Ellis et al. 1978
      Geist 1971a

   c. Grading/plowing

      Elliott 1983
      Goodson 1982
      Jakimchuk et al. 1984
      McCrory 1975
      McKendrick et al. 1984
      Riggs and Peek 1980

   d. Transport of oil/gas/water - land, ice

      Jakimchuk et al. 1984
      Leslie and Douglas 1980
      McCrory 1975

   e. Transport of personnel/equipment/material - land, ice

      Ellis et al. 1978
      Geist 1971a
      Jakimchuk et al. 1984

Samuel et al. 1975

2. Barriers to movement, physical and behavioral:

   a. Clearing and tree harvest

      Millar 1983

   b. Fencing

      Buechner 1960
      Graf 1980
      Graham 1980
      Hansen 1971
      Helvie 1971
      Packard 1946

   c. Grading/plowing

      Geist 1971a
      Millar 1983

   d. Transport of oil/gas/water - land, ice

      Graf 1980
      Graham 1980

   e. Transport of personnel/equipment/material - land, ice

      Geist 1971a
      Graf 1980
      Graham 1980
      Hansen 1971
      Horejsi 1976
      Jorgensen 1974
      Millar 1983
      Stevens 1982
      Tracy 1977

   f. Water regulation/withdrawal/irrigation

      Graf 1980
      Graham 1980

3. Collision with vehicles or structures:

   a. Transport of personnel/equipment/material - land, ice

Geist 1971a
Graham 1980
Hansen 1971
Jakimchuk et al. 1984
Millar 1983

4. Entanglement in fishing nets, debris:

    a. Fencing

        Graham 1980
        Hansen 1971
        Helvie 1971

5. Entrapment in impoundments or excavations:

    a. Transport of oil/gas/water - land, ice

        Graham 1980

    b. Water regulation/withdrawal/irrigation

        Graham 1980

6. Harassment, active or passive:

    a. Blasting

        Graf 1980
        Pendergast et al. 1974
        USDI 1976a

    b. Clearing and tree harvest

        DeForge 1972
        Light 1971

    c. Drilling

        Geist 1971a

    d. Grading/plowing

        Geist 1975
        Graf 1980
        Hicks and Elder 1979
        Packard 1946

e. Grazing

Buechner 1960
Goodson 1982

f. Human disturbance

Andersen and Klein 1971
Buechner 1960
Campbell and Remington 1981
DeForge 1972
Dunaway 1971
Geist 1971a
Geist 1975
Graf 1980
Graham 1971
Graham 1980
Hansen 1971
Heimer 1978
Hicks and Elder 1979
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Leslie and Douglas 1980
Light 1971
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Packard 1946
Price and Lent 1972
Stemp 1982
Stevens 1982
Tracy 1977

g. Processing minerals (including gravel)

Geist 1975

h. Sewage disposal

Graham 1980

i. Transport of oil/gas/water - land, ice

Campbell and Remington 1981
Graf 1980
Leslie and Douglas 1980
McCourt et al. 1974
Reynolds 1974
USDI 1976a

j. Transport of personnel/equipment/material - air

Geist 1971a
Graham 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Krausman and Hervert 1983
Lenarz 1974
Linderman 1972
MacArthur et al. 1979
MacArthur et al. 1982
McCourt et al. 1974
Nette et al. 1984
Nichols and Heimer 1972
Pitzman 1970
Price and Lent 1972
Reynolds 1974
Singer and Mullen 1981
Stemp 1982
USDI 1976a

k. Transport of personnel/equipment/material - land, ice

DeForge 1972
Geist 1971a
Graf 1980
Heimer 1978
Horejsi 1976
Jakimchuk et al. 1984
Jorgensen 1974
Light 1973
MacArthur et al. 1979
MacArthur et al. 1982
Millar 1983
Packard 1946
Price and Lent 1972
Stevens 1982
Tracy 1977

l. Water regulation/withdrawal/irrigation

Graf 1980

7. Harvest, change in level:

a. Transport of personnel/equipment/material - land, ice

Geist 1971a

Graf 1980
Hansen 1971
Jakimchuk et al. 1984
Packard 1946

8. Introduced wild/domestic species, competition:

   a. Chemical application

      Blood 1971
      Samuel et al. 1975

   b. Grazing

      Blood 1971
      Bodie and Hickey 1980
      Buechner 1960
      Dieterich et al. 1981
      Foreyt and Jessup 1982
      Goodson 1982
      Graham 1980
      Hansen 1971
      Hoefs and Brink 1978
      Howe et al. 1966
      Klebesadel and Restad 1981
      McCollough et al. 1980
      Packard 1946
      Post 1971
      Preston 1983b
      Robinson et al. 1967
      Samuel et al. 1975
      Smith et al. 1982

   c. Human disturbance

      Geist 1971a

   d. Transport of personnel/equipment/material - land, ice

      Geist 1971a

9. Parasitism/predation, increased susceptibility:

   a. Clearing and tree harvest

      Woodard et al. 1974

   b. Fencing

Buechner 1960
Packard 1946

c. Grading/plowing

Packard 1946
Woodard et al. 1974

d. Grazing

Buechner 1960
Hansen 1971
Packard 1946
Woodard et al. 1974

e. Human disturbance

Buechner 1960
Packard 1946
Wishart et al. 1980

f. Transport of personnel/equipment/material - air

Nette et al. 1984

10. Terrain alteration or destruction:

a. Grading/plowing

Graf 1980

b. Transport of oil/gas/water - land, ice

Graf 1980

11. Veg. composition, change to less preferred:

a. Clearing and tree harvest

Elliott 1983

b. Grading/plowing

Elliott 1983

c. Grazing

Bodie and Hickey 1980

Demarchi 1970

12. Veg. damage/destruction due to grazing:

    a. Grazing

        Bodie and Hickey 1980
        Buechner 1960
        Demarchi 1970
        Graham 1980
        Hansen 1971
        Hoefs and Brink 1978
        Packard 1946
        Post 1971
        Stevens 1982

13. Veg. damage/destruction due to erosion:

    a. Clearing and tree harvest

        Millar 1983

    b. Grading/plowing

        Graf 1980
        Hansen 1971
        McKendrick et al. 1984
        Millar 1983
        Packard 1946

14. Water level or water quality fluctuations:

    a. Grazing

        Hansen 1971

ANNOTATED REFERENCES TO IMPACTS TO MOOSE

The annotated bibliography contains only references that discuss documented impacts to moose. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to moose are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

ADF&G. 1983. Big game data information files. Div. Game (ADF&G-A)#

In these data files, counts of the verified kills by Alaska Rairoad trains of moose of all life stages present in winter between Palmer and Wasilla (GMU 14A) and between Willow airport and Talkeetna station (GMU 14B) made in late spring from the winter of 1970-71 through 1981-82 are reported by age class and sex. Kills by highway vehicles throughout the year from 1972-73 (June 1 to May 31) through 1978-79 are similarly categorized. Habitat types included boreal forest of white and black spruce, birch, aspen, and balsam poplar, muskeg, and riparian areas. Train and highway vehicle operation was responsible for the documented direct impact of collisions. Conclusive results are summarized below:

	GMU 14A		GMU 14B	
Year	Train	Road	Train	Road
1970-71	22	--	114	--
1971-72	--	--	75	--
1972-73	0	36	10	3
1973-74	7	33	--	6
1974-75	21	63	47	5
1975-76	3	29	--	1
1976-77	--	56	--	7
1977-78	--	67	--	5
1978-79	27	108	151	41
1979-80	--	--	9	--
1980-81	--	--	6	--
1981-82	--	--	9	--

Note: -- denotes data not included in this field.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Altmann, M. 1958. The flight distance in free-ranging big game. J. Wildl. Manage. 22(2):207-209. (UAF)*

In this field research article, the responses of moose of all life stages to a human on foot in Wyoming (specific location[s] not given) during all seasons of a 3-yr period (years not stated) were determined. Brief observations of elk and mule deer were also made. The geographic area is located south of Alaska, but the high elevation of the study location results in habitat types similar to those utilized by moose in Alaska: coniferous and aspen forests, riparian zones, and moist meadows. The activity of human disturbance was responsible for the direct documented impacts of active and passive harassment. Conclusive results showed that the flight distance (the distance to which a person can approach a wild animal without causing it to flee) for moose is variable, depending upon the season, habitat type, and the specific experience of an animal or group. Short flight distances of 3-27.5 m (10-90 ft) were characteristic of cows with new calves, prerutting bulls, both sexes during the rut (except when hunted), winter groups, and feeding in water, whereas long distances of 30.5-61 m (100-200 ft) were characteristic of cows with heeling calves and bulls in velvet. The flight distance of both sexes became very long, 61-91.5 m (200-300 ft), during hunting season. Flight distance was also shorter for habituated moose, in dense vegetation, and at dusk and dawn. The latter was also true for deer and elk.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Anonymous. 1985a. ARR takes action over moose killings. Fairbanks Daily News-Miner, March 3. (ADF&G-F)*

In this news article, collisions between moose of all life stages and freight trains operating on the Alaska Railroad between Anchorage and Fairbanks on February 27 and 28, 1985, are discussed. Most of the collisions occurred between Willow and Talkeetna, where the habitat types include boreal forest of white spruce, aspen, birch, and balsam poplar, successional areas of willows and other shrubs, and some muskeg and riparian areas. The activity of transporting personnel/equipment/material by land was responsible for the documented direct impact of collision with vehicles. Snow depths 50% higher than normal conclusively resulted in moose seeking out the tracks for easier walking. On two days, in which two round trips were made, a total of 47 moose were killed by collisions. Potential mitigative guidelines are 1) to operate trains at less than 64 kph (40 mph) in moose habitat where snowfall is extreme and 2) to clear feeding areas for moose away from the tracks.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Anonymous. 1985b. Fewer moose are killed by state trains. Fairbanks Daily News-Miner, March 5. (ADF&G-F)*

In this news article, collisions between moose of all life stages and freight trains operating on the Alaska Railroad (ARR) between Anchorage and Fairbanks from February 24 through March 3, 1985, are discussed. Most of the collisions occurred between Willow and Talkeetna, where the habitat types include boreal forest of white spruce, aspen, birch, and balsam poplar, successional areas of willows and other shrubs, and some muskeg and riparian areas. The activity of transporting personnel/equipment/material by land was responsible for the documented direct impact of collision with vehicles. Over a four-day period, 75 moose were killed in collisions with trains, 24 on a single night. An average of 100-200 moose are killed by train collisions along the ARR each winter. After the following mitigative measures were adopted, only three moose were killed in one night: 1) decrease train speed in high danger areas from 64 kph (40 mph) to 48 kph (30 mph); 2) turn off the train headlight upon spotting a moose, to avoid mesmerizing the animal; 3) utilize a Save-A-Life device on the engine, which generates a high-pitched squeal, inaudible to humans, to scare moose; and 4) plow areas off the tracks to give moose some place else to congregate. Several moose were seen fleeing the train after the third measure was adopted.

[Reviewer's note: Most moose in the vicinity of the railroad may have been killed prior to adoption of these measures, so their effectiveness may not be as great as it appears. The Save-A-Life device does scare moose, for example, but they run along the tracks and are killed anyway (pers. comm. M.G. McDonald, 1985).]

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Bangs, E.E., and T.N. Bailey. 1982. Moose movement and distribution in response to winter seismological exploration on the Kenai National Wildlife Refuge, Alaska. Unpubl. final rept. prepared for ARCO, Alaska, Inc., Anchorage, AK. 46 pp. (ADF&G-F)

In this field research article, the effect of seismic blasting during the winter on moose of both sexes two years of age or older from November 1980 through January 1982 was determined in the Finger Lakes and Slikok Lake areas of the lowlands of the northwest part of the Kenai Peninsula, Alaska. The habitat type was boreal forest of white and black spruce, birch, and aspen, including boggy areas, lakes, creeks, and recently burned areas. The study sites were in high-quality winter moose range. Seismic exploration in which all equipment and personnel were moved by helicopter or on foot and in which 36 one-pound explosives detonated simultaneously on the snow surface at each shot point provided the seismic signal resulted in the documented direct impact of passive harassment. Conclusive results showed that moose ran from field crews on foot setting out shot points or geophone arrays within a distance of 100 m (328 ft) and from light aircraft at an unstated distance. Moose in open habitat were more likely to react than those in cover. During seismic exploration, moose in the exploration area used a greater proportion of their winter range than did the undisturbed population, an indication that the disturbance caused greater movements, but no moose left the area. No effect of seismic exploration was detected on behavior patterns, group composition or size, use of cover or edge habitats, use of other habitat types, or sensitivity to disturbance. Neither habituation nor increased sensitivity to disturbance was observed. The results must be qualified by the facts that the moose populations, especially the experimental one, had previously been habituated to human disturbance and that little or no snow fell during the experimental winter, the mildest winter of the unstated period that weather records for the area have been kept.

Activity: blasting; human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Bangs, E.E., T.H. Spraker, T.N. Bailey, and V.D. Berns. 1982. Effects of increased human populations on wildlife resources of the Kenai Peninsula, Alaska. Trans. N. Am. Wildl. Nat. Resour. Conf. 47:605-616. (UAF)

This paper reviews the historical impacts, management techniques, and potential human impacts on trumpeter swans, Bald Eagles, salmon, wolves, caribou, and moose on the Kenai Peninsula, Alaska. The information reviewed dates to the early 1900's, although the majority of the impact-related information is from the 1960's and 1970's. Habitat types in the area range from coastal forest to alpine tundra.

Trumpeter swans. The activity of human disturbance produced the direct documented and potential impacts of active and passive harassment. Human disturbance associated with residential and industrial development was suspected to have caused abandonment of a spring staging area and several nest sites. Continued disturbance was expected to occur with further human development within the area.

Bald Eagle. The activities of human disturbance and transporting personnel/equipment/material by water produced documented direct impacts of active and passive harassment. Eaglet production was substantially less in areas subjected to human disturbance than in areas subjected to little disturbance. Potential impacts that may be associated with roads and transmission lines from the Bradley Lake power project include electrocution from contact with powerlines and passive harassment.

Moose. The activities of human disturbance and transporting personnel/equipment/material by land resulted in direct, documented impacts of moose colliding with vehicles and increased susceptibility to predation. Conclusive results show that between 1970 and 1980 an average of 150 moose were killed annually by colliding with vehicles and that an undetermined number of calves were killed by domestic dogs.

Wolves. The activities of human disturbance and processing minerals resulted in direct, documented impacts of disease transmission from domesticated animals, passive harassment, and drastically increased harvest. By 1915, widespread use of poison and unregulated hunting and trapping had extirpated wolves from the Kenai Peninsula. After recolonization, it is believed that at least one wolf pack has been reduced by contracting distemper from domestic dogs. Intensively developed lands, which wolves avoid, have reduced wolf habitat on the Kenai Peninsula.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; parasitism and predation, increased susceptibility to.

Bergerud, A.T., F. Manuel, and H. Whalen. 1968. Harvest reduction of a moose population in Newfoundland. J. Wildl. Manage. 32(4):722-728. (UAF)

In this field research report, the effects of opening new roads on the harvest of moose were studied in central Newfoundland between 1952 and 1961. The work was conducted during fall and early winter harvest seasons. During 1960 and 1961, moose of all life stages were hunted; harvest regulations in other years are not described. Although the habitat type of eastern boreal forest of balsam fir and paper birch is not identical to that of Alaska and the area is at a more southerly latitude than Alaska, the effects of increased access on harvest of moose are expected to be similar. The activities of road construction and repair and of transport of hunters by land and by boat were responsible for the documented direct impact of increased harvest. Harvest increased slightly in 1958, after a new road to the area was opened to hunters, and greatly in 1960 and 1961, after several logging roads were repaired and opened to hunters, a boat service to inaccessible areas on two lakes was provided, logging camps were made available as hunting camps, and seasons and bag limits were liberalized. No mitigation recommendations were made.

Activity: grading/plowing; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harvest, change in level.

Brusnyk, L.M., and F.F. Gilbert. 1983. Use of shoreline timber reserves by moose. J. Wildl. Manage. 47(3):673-685. (GD)#

The importance of shoreline timber reserves to moose (Alces alces) was studied in the Chapleau Crown Game Preserve, Ontario, from fall 1978 to winter 1980. Three types (shoreline reserves, natural, and cut areas) around selected lakes were studied for seasonal use by moose using pellet-plot data supplemented by track counts and winter aerial surveys. Reserve areas had greater (p less than 0.01) pellet-group densities than the natural and cut types during both winter periods. Results of aerial surveys corroborated pellet-group findings. No differences (p greater than 0.05) in pellet-group densities or track counts were found among site types in the summer periods. Differences (p less than 0.05) in track-plot crossings were observed among study lakes. Moose preference for shoreline reserves during winter appeared related to edges. Reserve types offered a greater amount of coniferous cover adjacent to an abundant source of browse than did natural and cut areas. Summer use by moose appears to be governed by the availability of suitable aquatic feeding areas and terrestrial browse in adjacent cutovers.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Brusnyk, L., and B. Lunseth. 1985. Vegetation response and ungulate use of pipeline right-of-way. In International Society of Petroleum Industry Biologists 8th Annual Conference on Northern Hydrocarbon Development, Environmental Problem Solving. 24-26 Sept. Banff, Alberta. Abstract only. (ADF&G-F)*

In this field research report, the use of woody revegetation along a petroleum pipeline right-of-way (ROW) by moose of all life stages was studied in west-central Alberta during the early spring of an unstated year, when total use throughout the winter browsing season could be measured. Although the study area is located at a more southerly latitude than Alaska, the continental climate and mountainous terrain result in similar habitat types of closed-canopy coniferous, northern deciduous, and mixed forests. The activity of transport of petroleum by pipelines on land was responsible for the documented direct impact of attraction to an artificial food source. Conclusive results showed that moose browsed preferentially on woody browse that had regenerated naturally along a 17-yr old ROW through a closed-canopy forest. Browse had not yet been produced along a 2-yr old ROW. In terms of increasing moose winter browse, a recommendation was made to alter revegetation practices to encourage more rapid establishment of browse suitable for moose.

Activity: transport of oil/gas/water - land.

Impact: attraction to artificial food source.

Burris, O.E. 1965. Big game fences for Alaska. ADF&G, Information Leaflet No. 64. May. Juneau. 7 pp. (UAF)*

In this field research report, the design and testing of a fence through which moose of all life stages cannot pass is described. The tests were conducted at a dairy farm about 128 km (80 mi) south of Fairbanks in Interior Alaska during the growing season of an unstated year. Habitat types included boreal forest surrounding fields planted to an unstated crop. The activity of plowing and growing a crop was responsible for the documented direct impact of attraction of moose to an artificial food source, and the fence that was subsequently constructed was a physical barrier to moose movement. Conclusive results were that even though moose were accustomed to feeding on the crop, they were stopped by a barbed wire fence constructed of spruce poles 8-10 cm (3-4 in) in diameter spaced 10 m (33 ft) apart, leaning away from the field at an angle of 15-20° and strung with a charged wire 0.9 m (3 ft) above the ground, with additional uncharged wires at unstated distances above and below the charged wire. (In a photograph, the top wire appears to be 1.5-1.8 m (5-6 ft) above the ground.) Yellow plastic surveyors flagging was tied to all wires at intervals of 1.5-1.8 m (5-6 ft). Recommendations for designing a better low-maintenance fence to exclude moose are as follows: 1) construct the fence before crops become palatable; 2) clear all vegetation for 3 m (10 ft) outside the fence and hang yellow flagging on the fence at 1.5-1.8 m (5-6 ft) intervals for visibility; and 3) lean the fence outward at an angle of 45°. Material specifications are as follows:

Posts: spruce poles 10-15 cm (4-6 in) in diameter. The leaning (45° angle) posts are 3 m (10 ft) long and the vertical braces are 1.8-2.4 m (6-8 ft) long, set at 4.9 m (16 ft) intervals.

Barbed wire: 4-point, 12½ gauge or heavier.

Spacing of wires: Use 4-5 wires, the lowest 0.6 m (2 ft) above the ground, the highest 1.8 m (6 ft) or more above the ground. Charge at least a wire 0.9 m (3 ft) above the ground on the vertical braces, and preferably also the top wire. Heavy duty 15 cm (6 in) mesh stock wire 1 m (39 in) wide, with the bottom placed 0.5-0.6 m (1½-2 ft) above the ground, can replace all but the top barbed wire. In that case, charge the top wire.

[Reviewer's note: moose have become entangled in barbed wire fences (Preston 1983). No statement is made in this article about whether moose could be entangled in the recommended fence. Dall sheep could probably become entangled in the stock wire version, and the spacing of wires in the barbed wire version might result in injury or entanglement of sheep, if either fence were constructed in sheep habitat (Helvie 1971).]

Activity: fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Chatelain, E.F. 1951. Winter range problems of moose in the Susitna Valley. Pages 343-347 in L. Irving, pres. Alaska science conference, second proceedings. Alaska division, American Association for the Advancement of Science, Mt. McKinley Nat'l. Park, Sept. 4-8. 362. (UAF)

In this field research report and discussion article, characteristics of moose of all life stages and their winter habitat were studied in the Susitna River valley of Alaska during the winters of 1948-1949 through 1950-1951. Habitat types include boreal forests of aspen, balsam poplar, and white and black spruce, and fields and successional stands of willows and young broadleaf trees in burned and cleared areas. The activity of plowing and growing grass was responsible for the documented direct impact of attraction of moose to haystacks, and the activity of transport by rail was responsible for the documented direct impact of collisions between moose and trains. After the moose consume most of the available browse late in winter, they enter cultivated fields, eating and trampling haystacks. Flares, smokepots, and dogs have not prevented moose from entering fields. During winters of deep snow, moose regularly use the cleared railroad tracks between Houston and Talkeetna for travel within a large wintering area. During the winter of 1950-1951, 104 moose were killed by collisions with trains in that area. No mitigation guidelines were suggested.

Activity: grading/plowing; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines.

Child, K.N. 1983. Railway corridors and related moose mortality in the central interior of British Columbia. Proceedings of the nineteenth North American moose conference workshop. 586 pp. (ADF&G-A)#

The Canadian National and British Columbia railways traverse winter ranges of moose in the Central Interior. In winters of record snowfalls, moose intercept and travel along the rail grades. Many moose are injured, crippled, or killed. In the winters of 1969, 1974, 1978, and 1982, the annual loss of moose to train collisions was estimated to range from hundreds to in excess of 1,000 animals. Normal anti-predator behaviors were observed to be of little survival value to moose when confronting trains. Remedial actions are not apparent at this time. If no commitment to research is forthcoming, the magnitude of moose mortality is expected to increase significantly once grain and coal shipments move westwards by rail through the Central Interior. Management programs for moose may never achieve their desired aims as resource losses to train traffic may never be adequately recovered.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Cobus, M. 1972. Moose as an aesthetic resource and their summer feeding behavior. Pages 244-275 in R.B. Addison, ed. North American moose conference and workshop, 8th, Thunder Bay, Ontario, February. 339 pp. (UAF)*

In this field research report, the effect on moose of all life stages of viewing by humans was studied during the summer of 1971 at a shallow eutrophic lake on the north shore of Lake Superior, Ontario. Although the latitude of the area is south of Alaska and the habitat type is intermediate between the boreal forest and the mixed hardwood and pine forests of the northeastern United States, moose feed on similar vegetation and are expected to respond similarly to disturbance. The activities of viewing of moose and of driving along a highway were responsible for the documented direct impacts of active and passive harassment. Moose were habituated to the presence of humans and the road and were relatively unaffected by the sight and scent of humans but were scared by noise. Two young bulls left the lake at once after a group of campers on the shore 366 m (400 yd) away began talking at slightly louder than conversational volume. Other moose were harassed by the sound of an auto horn or by a car door slamming at a distance of 457 m (500 yd). No mitigation guidelines were suggested.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Crete, M. 1976. Importance of the logging operations on the winter habitat of moose in southwestern Quebec. Pages 31-53 in J.A. Hancock and W.F. Mercer, eds. Proceedings of the 12th North American moose conference and workshop. St. John's, Newfoundland. x + 313 pp. (ADF&G-F)*

In this field research report, the effects of tree harvest on winter range use by moose of all life stages were studied in southern Quebec, Canada, in January and March of 1974 and 1975. Winter habitat and use were further characterized by estimates of total winter use made after breakup. Although the latitude of the study area is south of Alaska, habitat types (including northern hardwood forests and mixed forests with conifers, aspen, and paper birch, including successional stages) are comparable. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. Conclusive results showed that selective harvesting of stands of shade-tolerant hardwoods (e.g., yellow birch, sugar maple) at two sites that produced no change in canopy closure or decreased canopy closure both increased winter use by moose compared to uncut stands for the next 20 years. The increase in use was greatest in the more intensively cut stands. Clear-cutting of conifers from mixed stands of shade-intolerant hardwoods (e.g., paper birch, aspen) resulted in increased winter use by moose compared to uncut stands when the canopy closure was little affected (40% of conifer basal area cut) and in decreased use at higher cutting levels (70% of conifer basal area). Logging damage to the understory shrubs and lack of snow interception by the canopy contributed to the decreased use by moose at the higher cutting level.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Davis, J.L., and A.W. Franzmann. 1979. Fire-moose-caribou interrelationships: a review and assessment. Pages 80-118 in H.G. Cumming, ed. North American moose conference and workshop, No. 15, Soldotna - Kenai, AK, March. 408 pp. (UAF)*

In this review paper, the effects of burning on moose of all life stages throughout all Nearctic moose ranges, including Alaska, are described. Papers cited were published between 1863 and 1978, including field research studies done at all seasons of the year and in all habitat types in which moose occur. Others were review papers. The activity of burning was responsible for the documented direct impacts of physical barriers to movement (the fire itself) and change in harvest level, and indirect impacts of terrain alteration (soil destruction), vegetation composition change and vegetation damage or destruction due to fire. Harvest of white spruce trees was responsible for the documented indirect impact of destruction of winter cover due to mechanical removal. Conclusive results of all of the papers reviewed are that the overall effects of burning are beneficial to moose. Burning of forests overcomes winter food limitations to moose populations by creating openings in which early successional vegetation prospers. Increased edges result in year-round use and increased forage variety. As well as forage quantity, forage quality is higher in early successional stands. Fat and protein percentages increase, and crude fiber decreases. Optimal burns are discontinuous and patchy - for example, the large 1947 burn on the Kenai Peninsula. Of the 260 km^2 (102 mi^2) area covered, only 53% was burned, resulting in 11,000 km (6,875 mi) of new ecotone and 60,000 patches where new stands of vegetation developed. Fires do result in impacts to moose, as well as benefits. Some moose are killed or forced to move during fires. On the Kenai Peninsula, 5 or 10 yr often elapse before burns produce significant browse. Clear, uniform burns lack mature forest stands that provide cover in mid-to-late winter, have increased snow depths on the ground, and facilitate hunting. Repeated high-temperature deep burns destroy soil and retard succession. Logging of remnant or regenerated white spruce stands removes winter cover for moose. No mitigation guidelines were recommended.

[Reviewers note: This is an excellent review, emphasizing the effects of fire on specific habitat characteristics that are limiting to moose.]

Activity: burning; clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; harvest, change in level; terrain alteration or destruction (e.g., raptor cliffs); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

deVos, A. 1958. Summer observations on moose behavior in Ontario. J. Mammal. 39(1):128-139. (UAF)

In this field research report, the effect of human disturbance on moose of all life stages was studied from May through August of 1952, 1953, and 1955 in Ontario, Canada. Although the latitude of the study area is south of Alaska, the continental climate results in boreal forest vegetation, including shallow lakes and marshes, characteristic of moose habitat in interior Alaska. The activity of human disturbance was responsible for the documented direct impact of active harassment. These moose were not habituated to humans. The author was sometimes able to approach moose to within 30 m (100 ft) without causing undue alarm. Moose feeding in water usually responded slowly, staring a minute or more, moving to shore, stopping to look back, and continuing to flee slowly or running after reaching cover. Moose often fled the author before he was able to shine a powerful flashlight on them after sunset. No management recommendations were made.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Doerr, J.G. 1983. Home range size, movements, and habitat use in two moose, _Alces alces_, populations in southeastern Alaska. Can. Field-Nat. 97(1):79-88. (UAF)*

In this field research report, movements and habitat use by adult cow moose in central southeastern Alaska were observed throughout the year between March 1978 and October 1981. Habitat types in the study area are old-growth spruce-fir coniferous forest, river terrace mixed forests of spruce, black cottonwood, and shrub thickets, and muskeg-scrub forests. The activity of clearing and tree harvest was responsible for documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of human disturbance was responsible for the documented direct impact of passive harassment. Conclusive results showed that several cow moose moved to new habitats that reduced the possibility of contact with hunters during the bull moose hunting season. Averaged over the year, unlogged river terrace forests were preferred over revegetating river terrace clear-cuts, but clear-cuts under 30 years of age (the only clear-cuts studied) in other forest types were preferred over high-volume, old-growth forests. On a seasonal basis, clear-cuts were used more frequently than uncut forests in November and December, and less frequently from June through August. Although clearcutting of old-growth rvier terrace forests resulted in impacts to moose, clearcutting stands in other old-growth forest types was beneficial for a period of about 30 yr. Floodplain winter habitat is very important at the uncut Stikine River site, where the activity of water regulation/withdrawal/irrigation may be responsible for the indirect potential impact of vegetation composition change. Mitigative recommendations at the clear-cut Thomas Bay site are 1) to sustain a mixture of high forage second-growth clear-cuts less than 30 yr in age and forested mid- and late-winter habitat and 2) to study the ability of precommercial thinning to prolong understory production and moose utilization of second-growth stands.

Activity: clearing and tree harvest; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Doerr, J.G., E.L. Young, and A.W. Franzmann. 1980. Ecological and physiological aspects of a moose population in Thomas Bay, southeast Alaska. Pages 203-237 in Proceedings of the 16th North American moose conference and workshop, Prince Albert, Saskatchewan, April. 586 pp. (UAF) *

In this field research report, the use of clear-cuts and old-growth forest by adult moose of both sexes in Thomas Bay, central Southeast Alaska, was investigated throughout the year from March 1978 through January 1980. Habitat types used by moose included Sitka spruce-western hemlock old-growth coastal forest, clear-cuts 6 to 26 years old, riparian stands of alder, willow, and black cottonwood, and muskeg-scrub timber. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. Conclusive results showed that moose were located in commercial old-growth forest and clear-cuts each about 33% of the time, averaged over the year. Clear-cut use was highest during November through January and April through May and half as great from June through September. Clear-cuts were not used at all during deep snow in February and March. Over the winter as a whole, old-growth stands were utilized more than adjacent clear-cuts. Among clear-cuts from 3 to 28 years of age, moose avoid those less than 8 years of age and prefer clear-cuts 8 to 19 years of age, although the fact that less productive, steeper, higher elevation sites were logged later confounds the results. After regrowth, conifers become dominant (very roughly at 15-25 years of age), the even-aged stand that persists for the rest of the rotational logging period of ca. 100 years is nearly devoid of available browse. Management recommendations include 1) developing economical methods of establishing greater quantities of willows and other high-quality browse in recently logged sites; 2) thinning conifer stands precommercially at ca. 15 years of age without cutting browse; 3) including forestry practices that shorten the rotational age, such as pulp sales; and 4) creating permanent openings up to 5 ha. in size by selective cutting of regrowth conifers beginning 20-30 years after clear-cutting and continuing every 10-20 years throughout the rotation period.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Doerr, J.G. In press. Considerations for managing moose habitat in the Petersburg Ranger District, Tongass National Forest, Southeast Alaska. Proceedings of the 1982 old-growth conference, Juneau. (ADF&G-F)*

In this field research and review article, the responses of moose of all life stages to clear-cutting and precommercial thinning at Thomas Bay, near Petersburg, Southeast Alaska, were studied by means of winter pellet group counts and forage measurements in the spring of 1981 and 1982 and in September 1981. The habitat type was moist temperate coastal forest of western hemlock and Sitka spruce, part of which had been clear-cut and the regrowth trees thinned. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage due to mechanical removal. Conclusive results showed that moose used clear-cuts ranging from 12 to 20 years in age that had been precommercially thinned three years earlier three to four times more intensively than adjacent old-growth forests during both mild and a severe winter. Stacking of thinning slash in piles had no effect on winter moose use. Retention of uncut old-growth forest in large blocks for use by moose during deep snow, clear-cutting blocks no more than 50-80 ha (125-200 ac) in extent, and clear-cutting new areas several years before forage production will decline in present clear-cuts at 25-35 years of age (to allow for low forage production the first several years after clear-cutting) are important to maintain high-quality moose habitat. Otherwise, clear-cutting is detrimental to moose. A model was developed to optimize the proportion of commercial forest sustained as moose habitat under various clear-cutting conditions. Management recommendations include the following: 1) retain river terrace forests and high-volume old growth at lower elevations for moose use; 2) disproportionately log lower volume old growth to provide high forage winter range; 3) thin clear-cuttings at 15-20 years of age at a spacing of 3.65 x 3.65 m (12 x 12 ft); 4) maintain a 50:50 ratio of forested winter range and high forage regrowth by partitioning timber harvest in equal proportions over the rotation period; and 5) shorten the harvest rotation from 100 years to 60 or 40 years.

[Reviewers note: this is an excellent review of the effects of tree harvest on moose in Alaska and outside. One point that is not addressed is the degree to which browse plants will persist in closed-canopy even-aged forests to regenerate high forage regrowth stands after the second and subsequent rounds of clear-cutting.]

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

EPA. 1982. Municipality of Anchorage sewage facility expansion. Draft Environmental Impact Statement. 98 pp. (UAA)#

In this environmental impact statement, moose of all ages and both sexes in the Anchorage bowl area from prior to urbanization in the early 1960's to 1982 are briefly discussed. Habitat types include boreal spruce forests and associated wetland and shrub vegetation. The activities of clearing and tree harvest, grading/plowing, human disturbance, sewage disposal, and transport of personnel/equipment/material by land, water, and air associated with urban development have been responsible for the documented direct impact of harassment and the indirect impact of vegetation damage/destruction due to mechanical removal or material overlay. Extensive development has greatly reduced the availability of winter forage areas, and moose are now concentrated in remaining narrow corridors along riparian zones and undeveloped areas. Potential impacts specific to the proposed sewage facility expansion were not stated in the Southwest Guide annotation.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Eastman, D.S. 1974. Habitat use by moose of burns, cutovers, and forests in north central British Columbia. Proc. N. Am. Moose Conf. Workshop 10:239-256. (ADF&G-A)#*

Habitat use by moose was studied in the subboreal spruce zone of British Columbia from 1971-1973 for dry, modal, and wet environments. Comparisons between burns, cutovers, and undisturbed forests were based on postwitner pellet-group counts and monthly checks of tagged twig transects in winter. Partially logged stands, 11-20 yr old, received the greatest use; burns were used at almost comparable levels. Recent clear-cuts were the least used habitat type, especially in heavy snowbelts. The use of forests was intermediate to clear-cuts, burns, and partial cutovers. For summer habitat, limited data indicated that selectively logged stands were used more than clear-cuts and forests. In all habitat types, winter use was greatest at the ecotones. Browsing rates varied considerably both within and between habitats but were generally highest in partial cutovers. The apparent contradiction between pellet-group and tagged-twig data demonstrated the need to assess habitat use by more than one method. Also, it revealed the importance of burns and cutovers as feeding areas in early winter and the probable importance of forests for shelter, especially in late winter.

Activity: burning; clearing and tree harvest.

Impact: vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc.

Eide, S., and S. Miller. 1979. Effects of the trans-Alaska pipeline on moose movements. ADF&G, Fed. Aid in Wildl. Rest. Final rept. Proj. W-17-10, Job 1.15R. 27 pp. Juneau. (GD)#*

In an attempt to evaluate the effect of the operational trans-Alaska oil pipeline on moose in the Nelchina Basin, moose encounters with the pipeline as revealed by tracks in the snow were studied. Particular emphasis was placed on the distance from the bottom of the pipe to the top of the pipeline pad (BOP-TOP). Statistical evaluation of these heights as related to moose crossings shows that although moose do not appear to cross the pipeline randomly, neither do they consistently select the higher pipe except when the pipeline is built at BOP-TOP heights of 1.5 m (5 ft) or less.

These results are compared with a similar study conducted during the construction phase of the pipeline in the same area during the preceding two winters, and the results are similar.

Other environmental considerations, such as sound, snow depths and icicles, are discussed. Snowfall for the winter of 1977-1978 is compared with historic weather patterns for the area. Snow depths for the winter of 1977-1978 were slightly below average.

Data are presented comparing moose sex and age composition counts from areas on either side of the pipeline, and the moose population is considered as being stable-to-increasing during the period of study.

Activity: transport of oil/gas/water - land.

Impact: barriers to movement, physical and behavioral.

Elliott, C. 1983. Food habits and habitat characteristics of wildlife species utilizing revegetated strip mine lands in Alaska. Exhibit IV-5 in Poker Flats mine permit application, Usibelli Coal Mine. June. (ADF&G-F) *

In this field research report, the effects of revegetation of strip-mined lands near Healy, Alaska, on all life stages of 26 species of mammals and birds, including coyote, fox, moose, sheep, and wolf, during all seasons of the year from 1980 to 1982, were examined. Undisturbed habitat types in this area of the northern foothills of the Alaska Range included open and closed spruce forest, shrub tundra, and barren floodplain. Areas disturbed 33 to 40 yr before the study had naturally revegetated to tall shrub habitat; other areas had been revegetated to grasses in 1972, 1976, and 1979. The activities of grading/plowing, human disturbance, and transport of personnel/equipment/material by land were responsible for documented direct impacts of attraction to artificial food source and passive harassment and the indirect impact of alteration of prey base. Potential impacts are also discussed. Conclusive results by species follow, then mitigative guidelines for all species.

Carnivorous furbearers. The absence of hares in areas revegetated to grasses has decreased prey availability for coyotes and, to a lesser degree, for wolves and foxes. Wolves avoid hunting in areas of frequent human presence but seek Dall sheep grazing in a revegetated area in winter.

Moose. Summer and winter browsing areas for moose have been eliminated in areas revegetated to grasses, whereas shrub stands in naturally revegetated roadsides and mined areas attract moose.

Sheep. One mined area that includes revegetated grass stands near a steep headwall and that winds keep snow-free provides low-quality sheep winter range, used in conjunction with natural tundra.

Mitigative guidelines for wildlife in general, including birds and small mammals, are 1) to promote a diversity of vegetation on areas to be mined and eventually reclaimed, by reserving areas such as riparian shrub zones and by avoiding reseeding to monotypic grass stands; 2) to construct haul roads with as low a berm as possible; 3) to place uprooted trees and brush in piles adjacent to undisturbed areas (as cover); 4) to reseed disturbed areas to native plants; and 5) if seeding to grasses must be done to control erosion, to use red fescue and bluejoint, the species most beneficial to wildlife.

Activity: clearing and tree harvest; grading/plowing.

Impact: attraction to artificial food source; vegetation composition, change to less preferred or useable species.

Ferguson, M.A.D., and L.B. Keith. 1982. Influence of nordic skiing on distribution of moose and elk in Elk Island National Park, Alberta. Can. Field-Nat. 96(1):69-78. (UAF)*

In this field research article, the response of moose and elk of all life stages in Elk Island National Park, central Alberta, to nordic skiing was studied during the winters (October-March) of 1970-1971 through 1977-1978. Although the geographic area is south of Alaska, the continental climate results in similar boreal forest habitat types: aspen and balsam poplar forests with some white spruce, open grass and shrub meadows, wetland shrub and sedge stands, and black spruce bogs. The activity of human disturbance was responsible for the documented direct impact of passive harassment. Cross-country skiing conclusively influenced moose distribution in the following ways: 1) a traditional shift in habitat use during the winter was accentuated after ski trails were built in areas from which moose normally moved; 2) during October-March, there were far fewer moose within 500 m (1,640 ft) of heavily used trails (100-215 persons/weekend day) than lightly used trails (0-9 persons/weekend day); 3) during the January-March ski season, moose densities were notably lower within 500 m (1,640 ft) of heavily used trails and where trails passed through open terrain; and 4) the daily displacement of moose away from trails occurred after the passage of the first skier(s) and was not accentuated by additional skiers. Unlike moose, the general distribution of elk was not affected by cross-country skiing. Elk did move away from trails, especially those heavily used; and as for moose, this response was independent of the number of skiers, once the first skier had passed.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Foster, D. 1985. Moose limits to be tighter. Anchorage Daily News 40(100):A1, A12. Thursday April 11. (ADF&G-F)*

In this news article, collisions between moose of all life stages, trains operating on the Alaska Railroad between Fairbanks and Anchorage, and highway vehicles throughout Alaska between November 1, 1984, and March 27, 1985, are discussed. Habitat types range from coastal spruce-fir forests through boreal forest of white and black spruce, aspen, birch, and balsam poplar to arctic tundra. The activity of transporting personnel/equipment/material by land was responsible for the documented direct impact of collision with vehicles. Nearly half of the 330 moose hit and killed by trains were wintering in Southcentral Alaska between Wasilla and Talkeetna. An additional 450 moose (an average number) were killed on state highways throughout Alaska. Mitigative techniques used by the railroad in areas of heavy snow accumulation included reducing speeds and plowing snow from a wider swath along the tracks.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Fraser, D., and E.R. Thomas. 1982. Moose-vehicle accidents in Ontario: relation to highway salt. Wildl. Soc. Bull. 10(3):261-265. (ADF&G-F) *

In this field research report, the relationship between the attraction of moose of all life stages to roadside pools that concentrate road salt and collisions of vehicles with moose was examined in southern Ontario from May through September of 1979 and 1980. Although the study area is south of Alaska, the habitat types at the ecotone between boreal forest and Great Lakes-St. Lawrence forest are very similar to those in forested parts of Alaska, with the exception of Southeast. The impacts discussed in this report are not dependent on forest type, however, and are applicable throughout Alaska. Spreading of rock salt on the asphalt highway during winter resulted in high salt concentrations in stagnant roadside pools throughout spring and summer. The sodium in these pools was responsible for the documented direct impacts of attracting moose to the road. As a result, some moose were conclusively involved in vehicle collisions. Lakes and ponds less than 100 m (328 ft) from the road had elevated salt concentrations. Moose use of ponds increased in May, peaked in June, and declined through July to very low levels in August and September. A much higher proportion of moose collisions occurred within 100 m (328 ft) of saline pools than expected on a chance basis. Mitigative recommendations include the following: 1) substitute more expensive (by 5-10 times) de-icing chemicals for sodium chloride, e.g., calcium chloride or ethylene glycol (urea is not recommended because of its cost and fertilizing effect on vegetation); 2) drain salty pools when possible; 3) prevent replenishment of salt in pools with salt from road shoulders by covering road shoulders with an impermeable surface (e.g., asphalt or buried plastic fabric) to allow rainwater to dilute the salt; 4) apply a cervid repellent to pools that cannot be otherwise treated during the peak collision season; and 5) establish artificial salt sources distant from the highway to discourage moose from using roadside ponds with low salt concentrations after more saline roadside pools have been drained, diluted, or treated with a repellent.

Activity: chemical application; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines.

Geist, V. 1963. On the behaviour of the North American moose (Alces alces Andersoni Peterson 1950) in British Columbia. Behav. 20 (3-4):377-416. (UAF) *

In this field research report, the responses of moose of all life stages to human disturbance were observed from May through September of 1959 and 1960 in British Columbia. Although the study area is at a more southerly latitude than Alaska, the habitat types of boreal forest in mountainous terrain with many large burned areas are similar to moose habitat in Alaska. The activity of human disturbance was responsible for the documented direct impacts of active and passive harassment. Calves and occasionally yearlings were indifferent to disturbance, in one case allowing hunters who had killed their mother to approach within 18 m (20 yd) before they fled, and in another circling and standing beside a cabin even after the occupant had walked out to view the yearling. An old bull moose, on the other hand, jumped at the sound of an axe chop 457-549 m (500-600 yd) away. At 274 m (300 yd), two separate moose were not disturbed by normal talking or by chopping wood. The sight of a human at close range (no distance stated) put all except a few yearling moose to flight.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Geist, V. 1971a. A behavioral approach to the management of wild ungulates. Pages 413-424 in E. Duffey and A.S. Watt, eds. The scientific management of plant and animal communities for conservation. Eleventh symposeum of the British Ecological Society. Blackwell Sci. Publ., Oxford, England. (ADF&G-F)*

In this review paper, the behavioral characteristics of wild ungulates including moose, Sitka black-tailed deer, mule deer (closely related to Sitka black-tailed deer), bighorn sheep (similar in behavior to Dall sheep), caribou, and reindeer (closely related to caribou), in various habitat types throughout the world, including arctic and subarctic areas, are discussed in relation to human disturbance. The original studies were made over the past three decades. The following activities are discussed: clearing, drilling, grading/plowing, human disturbance, and transporting personnel/equipment/ material by land and air. The results describing the direct impacts listed below are conclusive. Bighorn sheep are attracted to artificial food sources (stands of planted grasses) along highway embankments and ski runs and are killed by collisions with vehicles. Impassable barriers to movement of ungulates (species not specified) are created by snow ploughed off roads. Where several ungulate species coexist, significant changes in habitat preference by one species due to harassment may lead the "introduced" wild ungulate into competition with other wild ungulates, causing loss of other species. A change in harvest level (prolonged and extensive hunting) potentially will alter species biology to smaller, shorter-lived, more secretive forms of a species. Active and passive harassment has several detrimental effects, including increased susceptibility to predation and parasitism (lethal diseases in reindeer), mortality from emphysema (reindeer), running injury and calf trampling (reindeer), interference with weight gain and nutrition required for reproductive behavior (reindeer), and voluntary withdrawal from available habitat and confinement of the population to a smaller and maybe less favorable area. Returning to favorable habitat is most difficult and the effects of disturbance most severe for non-nomadic social species such as mountain sheep, and easiest for nongregarious ungulates (e.g., moose and deer) and nomadic social species (e.g., caribou). Recommendations are that habitat conservation alone will not ensure success in maintaining populations of ungulates, particularly of social species. The fact that human contact results in learning (usually to the benefit of neither the ungulates nor man) must be employed constructively; steps may have to be taken to educate both visitors and ungulates in areas where visitors are common and to modify visitor behavior so as not to alienate the ungulates.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Geist, V. 1971b. Is big game harassment harmful? Oilweek 22(7):12-13. (ADF&G-F)

The results of human disturbance of arctic ruminants, including moose, by low-flying aircraft (no altitude stated) for photography or sightseeing are discussed in this article written for persons involved in field exploration. Habitat types covered are the arctic tundra and adjacent open boreal forest. The documented impact is active harassment, for which the results of studies are mentioned but not referenced. Excessive running is likely to precipitate lethal emphysema and, in heavily pregnant cows, abortion. A loss of 17% of body weight early in gestation, which may result from natural stresses combined with harassment, causes reindeer cows to resorb the fetus. Data and assumptions are listed that enable calculation of the energy cost to ruminants of running and excitement. Other direct impacts of human disturbance discussed but not documented are increased susceptibility of newborn young to predation and of caribou to parasitism by insects. Young may also be abandoned or trampled. The unpredictability of aircraft does not allow ruminants to become accustomed to them, resulting in excitement at the sound or sight of an aircraft and imbalance of the hormonal system. The latter adversely affects the developing embryo.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gill, D. 1973. Modification of northern alluvial habitats by river development. Canad. Geogr. 17(2):138-153. (UAF)*

In this review and discussion article, the effects of impoundment or diversion of northern rivers on downstream areas, particularly the effects of the impoundment of the Peace River on the Peace-Athabasca Delta of northeastern Alberta, Canada, are described. Impacts are documented on all life stages of bison, freshwater fish, furbearers (muskrat), and moose; potential impacts for which detailed mechanisms are explained are described on ducks, geese, beaver, mink, and caribou. The area is at the latitude of south-central Alaska but with a continental climate comparable to that of interior Alaska. Dates of the field studies discussed are not stated, but the Bennett Dam on the Peace River was closed in 1969, and the major symposium on the effects was held in January 1971. Both winter and summer research is described. Habitat types include all low-elevation boreal forest types: mixed and white spruce forests, black spruce stands, muskeg, shallow lakes and sedge meadows and wetlands, and successional stands of willows along watercourses. The activity of impoundment of the river was responsible for the documented indirect impact on furbearers of decreased water levels below the dam and for the documented indirect impact on moose of vegetation succession due to decreased water levels and the absence of the scouring effects of the spring flood. Conclusive results are that very few muskrats overwintered in the delta since the dam was closed because the shallow lakes freeze to the bottom, killing the muskrats. Harvest of pelts two years after closure of the dam was only 3% of the average harvest for 9 yr prior to closure. Willow stands suitable as moose browse have temporarily increased, replacing shallow marsh Carex meadows, but are being replaced more slowly by spruce, which is used only for cover by moose. Mitigation recommendations are the following: 1) duplicate the natural flow regime as closely as possible below dams used for hydroelectric power, rather than impounding a maximum amount of spring runoff; and 2) avoid impounding northern rivers for diversion, because maintenance of near natural flows below the impoundments would be impossible and the habitat for fish and wildlife would markedly deteriorate.

Activity: water regulation/withdrawal/irrigation.

Impact: vegetation composition, change to less preferred or useable species.

Grauvogel, C.A. 1984. Seward Peninsula moose population identity study. ADF&G, Fed. Aid in Wildl. Rest. Final rept. Vol. 3. Proj. W-22-2, Job 1.29R. Juneau. 93 pp. (ADF&G-F)*

In this field research report, the movements and physical condition of adult moose of both sexes on the Seward Peninsula, Alaska, were studied between April 1981 and April 1984. Collared moose were relocated on a monthly basis throughout the year. Habitat types included wet tundra at lower elevations, dry tundra at higher elevations, and riparian willow stands of tall shrubs 1-4.5 m (3.3-14.8 ft) in height along all rivers and into the headwaters of all tributaries. The activity of grazing was responsible for the documented direct impact of disease transmission from domestic animals, and the activities of human disturbance, transporting personnel/equipment/material by land and water were responsible for the documented direct impact of change in level of harvest and the strongly suspected direct impacts of active and passive harassment. Tentative results of serological tests showed that one moose (2% of sample) may have been exposed to brucellosis carried by reindeer or their predators. Conclusive results showed that hunting pressure and success have increased dramatically in the Kuzitrin drainage between 1970 and 1980 and that hunting is concentrated along the transportation corridors of roads and rivers. Selective harvest of bull moose arriving at winter range in September has tentatively altered moose behavior, so that moose now arrive after November (mild winters may also be a factor). The population is highly migratory, so that most moose cross transportation corridors. Mitigative recommendations include the following: 1) discourage major developments on winter range along rivers, especially if they substantially increase human activity; 2) plan land transportation corridors to follow ridges and hilltops rather than river channels; and 3) keep transportation corridors direct and to a minimum.

Activity: grazing; human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from.

Grenier, P. 1973. Moose killed on the highway in the Laurentides Park, Quebec, 1962 to 1972. Pages 155-194 in R.B. Addison, ed. North American moose conference and workshop, 9th, Quebec City, Quebec. March. 243 pp. (UAF)

In this field research report, mortality of moose of all life stages due to collisions with automobiles was studied throughout the year between 1962 and 1972 in Laurentides Park, 48 km (30 mi) north of Quebec City, Quebec. Although the study area is located south of the latitude of Alaska, the habitat type of boreal forest is similar to that of interior Alaska. The activity of chemical application was responsible for the documented direct impact of attraction to an artificial food source, and the activity of transporting personnel/equipment/material by land was responsible for the documented direct impact of collisions with vehicles. The highway is paved, two lanes wide, with a speed limit of 96 kph (60 mph). A large amount (28.2 metric tons/km/yr, 49.6 tons/mi/yr) of sodium chloride and a lesser amount (0.45 metric tons/km/yr, 0.79 tons/mi/yr) of calcium chloride are spread on the road to melt snow and ice in winter. Ponds and ditches within 3 m (10 ft) of the road had sodium concentrations 100 times and calcium concentrations 3 times those of ponds along an unsalted secondary road. Moose use of ponds was related to salt concentration, and 2.3 times more moose were killed by collisions within 400 m (1,312 ft) of saline ponds than along other sections of the road. However, frequency of use of ponds was not related to risk of a collision. The number of moose killed per vehicle was highest in June and July and lower from August through October. Most collisions occurred between June and August, more than 80% at night. Collisions occurred throughout the night. No mitigation guidelines are suggested.

Activity: chemical application; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines.

Hamilton, G.D., and P.D. Drysdale. 1975. Effects of cutover width on browse utilization by moose. Pages 5-26 in V. Crichton, chairman. Eleventh North American moose conference and workshop, Winnipeg, Manitoba, March. 522 pp. (UAF)*

In this field research report, the effects of clear-cutting on habitat used by moose of all life stages were studied in southwestern Ontario, about 160 km (100 mi) northwest of Thunder Bay, during an unstated year and time of year. Although the study area is at a more southerly latitude than Alaska, the habitat type of boreal forest is similar, though richer in species composition. The activity of tree harvest was responsible for the documented indirect impact of vegetation composition change. Two cutover areas were studied: a spruce stand about 80 ha (200 ac) in extent cut in 1968-69 and a jack pine stand about 30 ha (75 ac) in extent cut in 1969-70. Uncut aspen patches remained as open (softwoods selectively cut) or closed pure stands in both cutovers. Conclusive results were that use of clear-cut areas by moose was lower than use of selectively cut areas where both browse and cover were available. In the larger area (maximum width more than 300 m [984 ft]), use decreased with increasing distance from cover, especially beyond 40 m (131 ft), and declined to zero at 100 m (328 ft). In the smaller area (maximum width less than 200 m [656 ft]), there were no significant changes in use with respect to distance from cover. No mitigation guidelines were proposed.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species.

Hancock, J.A. 1976. Human disturbance as a factor in managing moose populations. Pages 155-172 in J.A. Hancock and W.E. Mercer, eds. Proceedings of the 12th North American moose conference and workshop, St. John's, Newfoundland. x + 313 pp. (ADF&G-F)*

In this field research report, the effects of human disturbance on winter range use by moose of all life stages and on summer distribution of moose were studied in the central portion of the Avalon Peninsula, Newfoundland, Canada, in the summer of 1975. Although the study area is south of Alaska, it is within the boreal forest zone, and the habitat types are similar to those utilized by moose in Alaska: black spruce bogs and marshes and low ridges forested with paper birch and conifers. The activities of clearing and tree harvest, human disturbance, and transporting personnel/equipment/material by land and water were responsible for the documented direct impact of passive harassment. Conclusive results showed that in spite of equivalent habitat suitability in terms of available winter browse in areas of high, medium, and low human disturbance due to winter and summer motorized and nonmotorized recreation, cottage development, and some tree harvest, moose avoided areas of high and medium disturbance throughout the winter and also in late May. The disturbance effect extended 1-2 km (0.6-1.25 mi) from the perimeter of any disturbed area. The author recognizes the fact that some forestry operations may ultimately be advantageous in terms of producing new moose browse.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Haney, S. 1985. Delta fish-game names three. Fairbanks Daily News-Miner, February 6 Edition. (ADF&G-F)

In this brief news report, the killing of moose of all life stages in the Delta area of interior Alaska by collisions with road vehicles during the fall and early winter of 1984-1985 is mentioned. Habitat types range from boreal forests of white spruce, aspen, and paper birch through black spruce muskegs, riparian and shallow lake areas, subalpine shrub zones, and alpine tundra. The activity of transport of personnel/equipment/material by land was responsible for the documented direct impact of collision with vehicles. Twenty moose were killed between September 1984 and January 1985 on the highways between Birch Lake and Summit Lake and the Robertson River.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Hanley, P.T., J.E. Hemming, J.W. Morsell, T.A. Morehouse, L.E. Leask, and G.S. Harrison. 1981. Natural resource protection and petroleum development in Alaska. USFWS, Office of Biol. Services, Washington, D.C. August. 306 pp. (ADF&G-A)*

In this review and discussion article, the effects of petroleum development on moose, black and brown bear, arctic and red fox, and wolf of all life stages on Alaska's North Slope, along the trans-Alaska pipeline, in the Cook Inlet area, and on the Kenai Peninsula are considered. The field studies upon which the article is based were performed at all seasons of the year at various times between 1944 and 1981. Habitat types range from arctic tundra on the North Slope to boreal forest on the Kenai Peninsula, including most habitat types in Alaska along the trans-Alaska pipeline. Effects on caribou, fish, and waterfowl of all life stages are also discussed. Documented impacts to fish and wildlife are few, as the article concentrates on physical alterations in the environment that may cause impacts to fish or wildlife. Mitigative guidelines are given but are not based on documented impacts.

Moose. The activity of transporting oil by land was responsible for the documented direct impact of barrier to movement. Conclusive results showed that moose passed under pipe at heights of 1.8-2.4 m (6-8 ft) more frequently than at other heights (also see VanBallenberghe 1978). The activity of transporting personnel/equipment/material by air was responsible for the potential direct impact of passive harassment. Conclusive results showed that overflights at altitudes of 305 m (1,000 ft) or less during low cloud conditions did not result in harassment of moose along the Colville River.

Bear. The activities of drilling and or transporting oil by land were responsible for the documented direct impact of attraction to an artificial food source. Conclusive results showed that brown bears were attracted to garbage in drilling camps in the NPR-A and that brown and black bears were attracted to construction camps and construction areas for the trans-Alaska pipeline. The activity of blasting was responsible for the documented direct impact of passive harassment. Brown bears within 2 km (1.25 mi) of winter seismic blasting in NPR-A conclusively moved their dens as a result of the blasts.

Arctic fox and wolf. The activities of drilling and of transporting oil by land were responsible for the direct documented impact of attraction to an artificial food source. Arctic foxes were attracted to construction camps for the trans-Alaska pipeline, and higher populations thrive in the Prudhoe Bay area than prior to development, because of feeding by humans and on garbage. Both wolves and foxes were attracted to NPR-A drilling camps.

Activity: transport of oil/gas/water - land; transport of personnel/equipment/material - air.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Hauge, T.M. 1985. Fencing guidelines. Letter to A.G. Ott, ADF&G, from animal damage specialist, Bureau of Wildlife Management, Dept. of Natural Resources, Wisconsin. 19 pp. (ADF&G-F)*

This field research letter and set of specifications describes fences that block the movements of white-tailed deer and moose of all life stages. White-tailed deer are related to Sitka black-tailed deer and are expected to respond similarly to fences. Although Wisconsin is at a more southerly latitude than Alaska, its continental climate results in habitat types somewhat similar to those in interior Alaska: coniferous and deciduous forests with muskegs and bogs in poorly drained areas. The dates of the studies upon which the fencing recommendations were made are not stated. The activity of fencing was responsible for the documented direct impact of barriers to movement. The recommended seven-strand electric fence conclusively blocked 90 to 95% of deer that tried to cross it. A similar fence, taller by an unstated amount, successfully blocked moose. The recommended fence is a vertical high-tensile seven-wire electric fence with the top wire at least 1.5 m (60 in) above the ground and the bottom wire about 20 cm (8 in) off the ground. Smooth 12½-gauge wire is used. Each wire is charged and connected independently to the charger. To cross gates, the seven wires are insulated and buried in black PVC tubing. (See the letter for other specifications for constructing the high-tensile electric fence.)

Activity: fencing.

Impact: barriers to movement, physical and behavioral.

Holechek, J.L., R. Valdez, S.D. Schemnitz, R.D. Pieper, and C.A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildl. Soc. Bull. 10:204-210. (UAF)*

In this review article, specialized domestic livestock grazing systems that are less detrimental than continuous livestock grazing or are beneficial to mule deer and moose of all life stages on multiple use rangelands are discussed. The studies reviewed were performed between 1931 and 1981 in all seasons of the year and in a variety of geographic areas and habitat types, from cold, arid shrub-grasslands in the central Rocky Mountains through pastures and riparian shrub areas in Oregon and British Columbia. Mule deer are closely related to Sitka black-tailed deer. Although moose are not specifically mentioned, riparian shrub communities similar to those used by moose are discussed. The geographic areas and habitat types are not strictly comparable to those in Alaska, but the types of impacts and general mitigative methods are expected to be similar. The activity of grazing was responsible for the documented indirect impact of vegetation damage or destruction due to grazing by domestic animals and the direct impact of competition with introduced domestic species. Conclusive results showed that mule deer preferred areas under deferred-rotation cattle grazing to those grazed continuously by cattle, the preference increasing with the frequency of deferment. The quality of grass forage for elk and mule deer was improved by light-to-moderate spring or early summer cattle grazing to remove old leaves. On mule deer ranges where grasses and browse shrubs compete, limited grazing of understory grasses and shrubs by cattle or domestic sheep increased productivity of browse shrubs. Management recommendations include the following: 1) to avoid loss or allow recovery of woody deciduous plants (e.g., willows) in riparian areas, fence riparian areas separately, use limited rotation grazing at low stocking levels, or graze sheep controlled by herding instead of cattle; 2) recognize that burning and/or mowing in some cases improves habitat for wildlife better than does livestock grazing; and 3) a rotation grazing system that results in excessive defoliation of an area in order to rest another will be detrimental to habitat, wildlife, and livestock.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to grazing by domestic or introduced animals.

Hunt, H.M. 1976. Big game utilization of hardwood cuts in Saskatchewan. Pages 91-126 in J.A. Hancock and W.E. Mercer, eds. North American moose conference and workshop, proceedings of the 12th, St. John's, Newfoundland. 313 pp. March. (UAF)*

In this field research report, the effects of clear-cutting of quaking aspen (Populus tremuloides) forests in the boreal forest zone of eastcentral Saskatchewan on winter distribution of moose of all life stages was studied during the winters of 1973-1974 and 1974-1975. Although the latitude of the study area is south of most of Alaska, the continental climate results in habitat types essentially the same as those in the Interior Region of Alaska. The activity of clear-cutting was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. Uncut stands were 70-100 yr old, and cut areas 1-10 yr old. Conclusive results showed that in winter, moose strongly preferred clear-cuts less than 2 yr old, slightly avoided 3-6-yr old cuts, and utilized 9-10-yr-old cuts slightly more than expected. The pattern of use, with a 50% higher density of moose within 0.4 km (0.25 mi) of clear-cuts than in the region as a whole and lower density at distances greater than 0.8 km (0.5 mi) from cuts, was independent of clear-cut age. Within clear-cuts, moose were distributed randomly at mean distances of 66-81 m (72-89 yd) from cover and 113-197 m (124-215 yd) from mature forest edge. Maximum distances moose were observed from cover were 221-322 m (242-352 yd). Moose avoided the central portions of clear-cuts where no residual cover (e.g., willow, small aspen, or black poplar stands) had been left during logging. No mitigation guidelines were proposed.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Irwin, L.L. 1975. Deer/moose relationships on a burn in northeast Minnesota, J. Wildl. Manage. 39(4):653-662. (GD)#

A study of habitat selection and distribution of white-tailed deer (Odocoileus virginianus) and moose (Alces alces) was conducted on a 5,920 ha (14,800 ac) burn that occurred in spring 1971 in northeast Minnesota. Most use of coniferous stands within the burn by both moose and deer occurred in late fall and early spring, but they selected deciduous stands above all others (p less than 0.05), especially in summer and fall. Moose and deer utilized aquatic communities from late May through June. Both species selected postburn communities that produced large amounts of preferred forage. Association coefficients confirmed moose and deer utilized similar communities in summer and fall, but by December they occurred in similar communities by chance. Aerial and ground observations of animal groups indicated that moose and deer used the burn during summer and the periphery and unburned forest during winter. Coefficients of dietary overlap indicated relatively high overlap occurred during fall, when deer used browse plants more often. This study suggests that large burns, which produce large quantities of woody forage in boreal forests, allow moose populations to increase despite the presence of deer and the pathogenic nematode parasite (Parelaphostrongylus tenuis).

Activity: burning.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism.

Joyce, M.R. 1980. Effects of gravel removal on terrestrial biota. Pages 215-272 in Woodward-Clyde Consultants, Gravel removal studies in arctic and subarctic floodplains in Alaska. Tech. rept., Biological Services Program, U.S. Environemtnal Protection Agency and USFWS. FWS/OBS-80.08 Washington, D.C. 403 pp.

In this field research report, the effects of gravel removal from floodplains in interior, arctic, and western Alaska on terrestrial wildlife, including moose, beaver, muskrat, and arctic ground squirrel of all life stages, were studied. Twenty-five sites were examined 2 to 20 yr after disturbance during the summers between spring 1976 and March 1979, and seven of those were also visited during the winters of 1977-1978 and 1978-1979. Habitat types include riparian forests of white spruce and balsom poplar, tall and low shrub stands, and herbaceous or sparse woody plant stands, or bare river bars in the arctic floodplain. Removal of gravel was responsible for the documented indirect impacts of terrain alteration or destruction, vegetation removal, and water level flucuations. Conclusive results were that significant amounts of dense riparian shrub thickets that provide critical feeding and cover habitats for moose during winter were removed from five sites. Moose most likely responded by increased reliance on adjacent undisturbed thickets or by shifts in winter distribution. Scraping of gravel to a level at or below the average height of summer flows at inside bends or immediately adjacent to or within the active channel resulted in long-term terrestrial habitat loss because of permanent flooding or river hydraulic changes leading to annual flooding, shifted channels, or aufeis accumulation. Under circumstances in which the above problems did not occur, natural revegetation was under way in about 10 yr and was hastened by the presence of overburden piles, woody slash and debris, displaced organic mats, or an abundant seed source in the mined area. At several sites with overburden piles, arctic ground squirrels were more abundant than in adjacent unmined areas. Beaver and muskrat utilized ponded areas in some mined sites along interior rivers. Mitigative guidelines are as follows: 1) whenever possible, avoid vegetated habitats; 2) when scraping in active or inactive floodplains, maintain buffers that will contain active channels to their original locations and configurations; 3) when small quanitities are required (approximately 50,000 m^3 or 65,350 yd^3), select sites that will scrape only unvegetated gravel deposits; 4) when large quantitites are required (approximately in excess of 50,000 m^3 or 65,350 yd^3), select large rivers containing sufficient gravel in unvegetated areas, or select terrace locations on the inactive side of the floodplain and mine by pit excavation; 5) if pit mining, design a configuration with high shoreline and water depth diversity and provide islands; and 6) if mining in vegetated areas, save all overburden and vegetative slash and debris to use during site rehabilitation to facilitate vegetative recovery. This material should be piled or broadcast in such a manner that it will not be washed downstream.

Activity: dredging; filling and pile-supported structures (aquatic).

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Joyce, M.R., L.A. Rundquist, L.L. Moulton, R.W. Firth, Jr., and E.H. Follman. 1980. Gravel removal guidelines manual for arctic and subarctic floodplains. USFWS by Woodward-Clyde Consultants. Office of Biological Services, USDI. Wash., D.C. 169 pp. (UAF)*

In this guidelines manual based on field research studies in floodplains of interior, arctic, and western Alaska, mitigation guidelines for the indirect impacts of gravel removal (terrain alteration or destruction, vegetation removal, and water quality fluctuations) on moose, arctic ground squirrels, beavers, and muskrats are presented in detail. Refer to Joyce 1980 for a summary of the guidelines and for the data upon which they are based.

Activity: dredging; filling and pile-supported structures (aquatic).

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Kertel, K. 1984. Wildlife and the effects of mining in the Kantishna Hills, Denali National Park and Preserve. National Park Service - Alaska Region, Research/Resources Manage. Rept. AR-2. USDI: NPS. 71 pp. (ADF&G-F)*

In this field research report, the effects of placer mining on moose, small mammals, and birds of all life stages were studied from May through August 1983 in the Kantishna Hills, Interior Alaska. Occasional observations on effects upon caribou and furbearers were made. Information on past and present distribution of other animals in the area is summarized from the literature. Habitat types included black spruce woodland, aspen-birch forest, alpine tundra, and riparian willow and alder stands. The activities of dredging and grading/plowing were responsible for the documented indirect impact on moose of vegetation composition change. Winter use by moose of riparian vegetation on unmined sites was conclusively shown to be 15 times greater than that of sites mined 40 yr ago. Potential impacts to caribou, moose, bears, wolves, furbearers, and raptors are listed. Management recommendations include the following: 1) leave corridors of undisturbed vegetation in mined riparian areas 2) save and reapply overburden and fines to mined surfaces, and 3) plant native vegetation to accelerate revegetation.

Activity: dredging; grading/plowing.

Impact: vegetation composition, change to less preferred or useable species.

Kinsey, C. 1976. Tests of two electric deer barrier forms. Minn. Wildl. Res. Quart. 36(3):122-138, and cover letter from P.D. Karns, Minnesota Department of Natural Resources, to A.G. Ott, ADF&G, 8 May 1985. (ADF&G-F) *

In this field research report, the responses of deer and moose of all life stages to single-wire electric fences were observed in late February and early March of 1975 and from October 1975 through March 1976 in farming areas of Minnesota. White-tailed deer are related to Sitka black-tailed deer and are expected to respond similarly to fences. Although the geographic area is at a more southerly latitude than Alaska and the habitat types of farmlands and northeastern mixed forest are not the same as those of Alaska, the behavior of deer and moose toward fences is expected to be independent of habitat type. The activity of plowing (farming) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Two types of inexpensive electric fences were tested. Both were about 80% effective in repelling deer from attractive concentrated food sources, including corn cribs, alfalfa haystacks, and silage, during the snow-free season, and they also repelled an unstated percentage of moose. Snow insulated deer from the ground and rendered the fences ineffective. The recommended fence consists of a single wire at a height of 55 cm (22 in) on which aluminum foil flags 7.5 cm by 10 cm (3 in by 4 in) are attached at 90-cm (35-in) intervals by folding them around both the wire and a piece of adhesive cotton tape soaked in an attractant of anise, clove, and corn oils in glycerin. More effective attractants evaluated in a separate test were apple pulp, corn meal, soybean meal, and especially peanut butter, but extracts of these foods suitable for use on cloth tape were not prepared. The fence is most effective if deer can approach it calmly and inquisitively; if chased toward it, they jump over. If the fence is left uncharged, deer will lose respect for it. Research is in progress on a two-wire fence that is effective in snow.

Activity: fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

This review article discusses the interactions between agriculture and wildlife, including bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl and the furbearers coyote, fox, lynx, marten, and wolverine of all life stages in Alaska and in the northern tier of the continguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine during white settlement is attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of Southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain growing areas in Alaska, in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep, and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: clearing and tree harvest; grading/plowing.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Klein, D.R. 1973. The reaction of some northern mammals to aircraft disturbance. Pages 377-383 in The eleventh international congress of game biologists, Stockholm, Sweden. (UAF)

In this field research paper, studies of the reactions of caribou, moose, brown bear, and wolf of all life stages occurring in summer to low-altitude aircraft (actual altitude not stated) were made during May through July 1973 in northeastern Alaska. The habitat type was arctic tundra. The activity of transporting personnel, equipment, or material by air was responsible for the documented direct impacts of active and passive harassment. Although this is a preliminary report of a study in progress and most of the observations were made on caribou (see separate annotation), tentative results are reported for the other species. Moose were usually indifferent to the single-engine, fixed-wing aircraft and helicopter, and those that ran were generally cows with young calves. Brown bears reacted very strongly, running at an unstated distance for cover or sharply away from the flight path. Wolves were disturbed very little, contrary to the extreme alarm the populations had shown until 4 yr previous, when aerial hunting was banned. Distances are not given. Animal populations had been habituated to 15-20 overflights annually, prior to the study.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Klein, D.R. 1979. The Alaska oil pipeline in retrospect. Trans. N. Am. Wildl. Nat. Resource Conf. 44:235-246. (GD)#

Caribou have not adjusted as well as moose to the presence of the trans-Alaska pipeline. Research has shown that caribou have altered their movements and patterns of range use in relation to the pipeline corridor. Cows with calves show pronounced avoidance of the pipeline, road, and oilfield. Traffic and human activity appear more directly responsible for avoidance behavior than does the physical presence of the pipeline, road, and facilities. Animals along the haul road are especially vulnerable to poaching because of the open terrain and the fact that many became tame during the peak of construction activity. Poaching, especially of furbearers, has increased as pipeline-related traffic has decreased.

Activity: transport of oil/gas/water-land; transport of personnel/equipment/material - land.

Impact: harvest, change in level.

Knopf, F.L., and R.W. Cannon. 1982. Structural resilience of a willow riparian community to changes in grazing practice. In J.M. Peek and P.D. Dalke, eds. Wildlife livestock relationships symposium: proceedings 10. Univ. Idaho, Forest, Wildlife and Range Experiment Station, Moscow, ID. 614 pp. (ADF&G-F)#

Many studies have shown that the diversity of an avian community is partly regulated by structural aspects of woody vegetation. The objective of this study was to quantify the impact of cattle (Bos taurus) on the physical structure of a high altitude willow (Salix spp.) community in Colorado. Cattle altered the size, shape, volume, and quantities of live and dead stems of bushes. In addition, cattle also influenced the spacing of plants and the width of a riparian tract. In contrast to studies that indicate fish habitats respond quickly to changes in grazing practices, terrestrial habitats respond slowly. The willow community tolerated heavy grazing pressures well initially but recovered slowly when damaged.

Activity: grazing.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals.

LeResche, R.E. 1966. Behavior and calf survival in Alaskan moose. M.S. Thesis, Univ. Alaska, Fairbanks, AK. (UAF)*

In this field research paper, behavior and calf survival of moose of all life stages were studied near Palmer, Alaska, from May through November 1965. Habitat types were open areas of wet sedge meadows and lakes, with stands of willow, alder, and black spruce along creeks; riparian forests of balsam poplar; and upland forests of birch, aspen, and white spruce. Tagging moose calves from a helicopter, surveying the moose population from a light fixed-wing aircraft, and observing of moose behavior by the author on foot were responsible for the documented direct impacts of active and passive harassment. A calf became entrapped by a leg in a shrub while fleeing the helicopter. Another calf found very recently dead of a broken skull had most likely been accidentally kicked by its dam, agitated by the helicopter's approach. When approached by a human on foot, moose of all life stages reacted with a similar variety of responses, ranging from precipitous flight to watchful interest. Flight distances ranged from less than 10 m (33 ft) to 100 m (328 ft) for yound bulls, and from 75 m (246 ft) to 300 m (984 ft) for cows with calves. Cows and calves assumed alert positions at distances greater than 100 m (328 ft) before taking flight. A calf was flushed at a distance of 10 m (33 ft). Cows with calves harassed by a helicopter first assumed a threat posture; then when the helicopter hovered within a few meters, most cows fled to a distance of 50 m (164 ft) or more, but about 15% did not abandon their calves even though the helicopter hovered 1 m (3 ft) above.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Leopold, A.S., and F.F. Darling. 1953. Effects of land use on moose and caribou in Alaska. Pages 553-562 in J.B. Trefethen, ed. Transactions of the 18th North American wildlife conference, Washington, D.C., March 9-11. Wildlife Mgt. Inst. 701 pp. (UAF)*

In this field survey, review, and discussion paper, the effects of land use on moose and caribou of all life stages in Alaska since the arrival of the white man are considered. Literature cited was written between 1940 and 1951 and includes studies done throughout Alaska at unstated seasons of the year, in addition to the authors' surveys during the summer of 1952. Habitat types include all those present in Arctic, Interior, Southwest, and Southcentral Alaska, from forests of white spruce and aspen to lichen tundra. For both species, the activities of burning, grading/plowing, and clearing and tree harvest were responsible for the documented indirect impacts of terrain alteration or destruction, vegetation damage or destruction due to fire or mechanical removal, and vegetation composition change. For caribou, the additional activity of grazing was responsible for the documented indirect impact of vegetation damage or destruction due to grazing by domestic animals. The authors conclude that greatly increased fire frequency in all parts of Alaska discussed except the arctic after the arrival of white miners, trappers, and hunters has improved moose winter range and increased moose populations while eliminating the slow-growing lichen winter range of caribou. Very hot fires destroy moose range as well, however. Clearing and subsequent abandonment of roads and farmsteads has effects similar to those of fire. Overgrazing of lichen winter ranges of caribou by introduced reindeer from 1892 through 1932 primarily in Western Alaska made the ranges unuseable by either species and broke once-continuous caribou habitat into small isolated pieces. Management recommendations include the following: 1) use controlled fire in Interior and Southcentral Alaska to improve critical winter moose range, especially near population centers, and 2) protect the remaining lichen ranges of caribou from fire.

[Reviewer's note: the conclusions in this paper are based on ecological theory, very limited field observations, and incomplete historical records. Supporting data on aspects such as lichen regrowth rates, actual extent of fires, and the possible role of infrequent fires in maintaining lichen productivity are lacking.]

Activity: burning; clearing and tree harvest; grading/plowing.

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Lynch, G.M. 1973. Influence of hunting on an Alberta moose herd. Pages 123-135 in R.B. Addison, ed. North American moose conference and workshop, 9th, Quebec City, Quebec, March. 243 pp. (UAF)

In this field research report, the effect of road construction on hunting pressure on moose of all life stages present in the fall and early winter was studied during the hunting season and by aerial surveys at unstated times of the year from 1970 through 1972 in west-central Alberta. Although the study area is at a latitude slightly south of Alaska, the habitat type of boreal forest dominated by white spruce stands is similar to that of interior Alaska. The activities of drilling and grading and plowing were responsible for the documented direct impact of an increase in harvest level. Prior to 1965, the study area had received light hunting pressure. By 1967, construction of oil and gas exploration and production roads and seismographic lines on a 2-mi grid had greatly improved access. Moose populations had increased to the level of overpopulation after wolf control, and hunting seasons were liberalized. The resultant hunting pressure was concentrated near roads, with 80% of the pressure within 1.6 km (1 mi) of roads.

Activity: drilling; grading/plowing.

Impact: harvest, change in level.

Matchett, M.R. 1984. Moose habitat selection in the Yaak country, northwestern Montana. Northwest Section, The Wildlife Society meeting. (Abstract, modified.) (ADF&G-F)*

In this field research article on work in progress, habitat use by moose in coniferous forest habitats of northwestern Montana was studied between June 1981 and June 1984. These habitats are similar to but more productive than spruce-hardwood forests in Alaska. The activity of clearing and tree harvest (clear-cutting) was responsible for documented indirect impacts of vegetation composition change to less preferred or useable species. Conclusive results were that most clear-cut use involved cuts less than 12 ha (30 ac) in size that had been cut more than 12 yr before this study. Edges of cuts were frequently used but central areas only when cover was abundant.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species.

McCourt, K.H., J.D. Feist, D. Doll, and J.J. Russell. 1974. Disturbance studies of caribou and other mammals in the Yukon and Alaska, 1972. Arctic Gas Biol. Rept. Ser., Vol. 5. Prepared by Renewable Resources Consulting Services, Ltd. (ADF&G-F) *#

In this field research report, Dall sheep and moose were studied in the northern Yukon and Alaska.

Dall sheep. A group of Dall sheep rams in alpine tundra habitat in the northern Richardson Mountains of the Yukon Territory were experimentally subjected to the simulated sound of a gas compressor station for two days in July 1972. This field research paper describes the results. The activities of transport of oil/gas/water by land and transporting personnel/equipment/material by air were responsible for the direct, documented impact of passive harassment. Weather was similar throughout the control and test periods. During periods of compressor simulation, conclusive results were that most sheep abandoned summer range within 1.6 km (1 mi) of the simulator. Bedding and feeding patterns of those that remained were altered. Helicopter disturbance was more severe, causing all but one ram to leave the area until 3 h after the helicopter disturbance. The possibility of habituation was not examined. The authors recommend that 1) sound-attenation measures be applied to any compressor stations located within 3.2 km (2 mi) of Dall sheep range and that, 2) by extrapolation, the location of borrow sites and the timing of construction in the vicinity of Dall sheep range will have to be carefully planned.

[Reviewer's note: These results are in apparent conflict with Reynolds (1974) but involved noncritical summer range rather than mineral licks. Weather problems in Reynolds' study, discussed in a note on that annotation, may also have affected the results.]

Moose. The activity of transporting personnel/equipment/material by air was responsible for the direct, documented impact of passive harassment. The reactions of moose to 46 incidences of aerial disturbance from fixed-winged aircraft were documented. Moose reacted 9 of 16 times to aircraft disturbance at elevations less than 61 m (200 ft); 9 out of 24 times from aerial disturbance in the 61 to 183 m (200 to 600 ft) range; and no reactions from 6 incidents of aerial disturbance from fixed-wing aircraft above 183 m (600 ft). Statements were made indicating that moose exhibit similar reactions to helicopters; however, those statements were not corroborated with any real data.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McMillan, J.F. 1954. Some observations on moose in Yellowstone Park. Am. Midl. Nat. 52(2):392-399. (UAF)

In this field research report, moose of all life stages were observed in Yellowstone National Park, Wyoming, during the summers of 1947-1949. Although the study area is located at a more southerly latitude than Alaska, the high elevation and continental climate result in habitat types similar to those utilized by moose in Alaska, including coniferous and aspen forests, willow stands, and wetlands and ponds. The activities of human disturbance and transport of personnel/equipment/material by land resulted in the direct documented impacts of active and passive harassment. Conclusive results showed that moose became habituated to disturbance by humans on foot. After habituation to a specific individual, moose feeding on land could be approached slowly and quietly to within 23-30.5 m (25-50 yd) and bedded moose to within 7.3-18 m (8-20 yd). The latter were alert, however. Moose feeding in water were disturbed at an unstated greater distance. Approach distances were 50% greater for persons to whom moose were not habituated. Even moose habituated to humans watched intently for up to several minutes if a human approached within a minimum of 91.5 m (100 yd); nonhabituated moose (in areas rarely frequented by humans) fled to cover at a minimum of 137 m (150 yd) and did not return to the same feeding areas that day. Movement combined with noise caused more harassment than did movement alone. Highway noise did not disturb habituated moose, nor did the human voice.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McNichol, J.G., and F.F. Gilbert. 1980. Late winter use of upland cutovers by moose. J. Wildl. Manage. 44(2):363-371. (UAF)*

In this field research paper, the use of regrowth in 10 to 15-year-old clear-cut areas of the boreal forest by moose of all life stages in upland areas of the Canadian shield 60-120 km (37.5-75 mi) northeast of Thunder Bay, Ontario, was examined from mid January to the end of February in 1974-1975. Although the study area is south of the latitude of Alaska, the strongly continental climate results in very similar habitat types of northern coniferous forest, including white spruce, paper birch, and aspen stands, black spruce muskeg, swamps, and shallow lakes. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal or material overlay. Conclusive results showed that the scattered-residual regrowth cover type, in which scattered mature trees had not been harvested, produced 50% more browse and a higher diversity of browse and was more heavily utilized by moose than were open clear-cuts (those in which no trees had been left and a dense shrub cover had developed) or cutovers that had regenerated to closed canopy coniferous stands. Moose use of cutovers was independent of the relative amount of cutover-border forest edge but decreased with increasing clear-cut size. In the absence of hunting or under light hunting pressure, moose use increased with increasing residual coniferous edge, and for cutovers greater than 130 ha (325 ac), residual conifers or well-established coniferous regeneration were necessary to allow use of all of the area. Under heavy fall hunting pressure only border areas of cutovers were used, regardless of the presence of residual or regenerated coniferous stands.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Monthey, R.W. 1984. Effects of timber harvesting on ungulates in northern Maine. J. Wildl. Manage. 48(1):279-285. (UAF)*

In this field research report, the effects of tree harvest on moose of all life stages in north-central Maine were studied during the winters of 1974-1977. Although the area is located at a latitude south of Alaska and the habitat type of northern mixed deciduous and coniferous forest includes a larger number of tree and shrub species than does the boreal forest of Alaska, browse production in, and moose utilization of undisturbed and logged forests is expected to be similar. The report discusses effects on white-tailed deer in as much detail as those on moose. The activity of tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage and destruction due to mechanical removal. Some of the forests studied had been commercially clear-cut 1-15 yr earlier. Patches of nonmerchantable trees and strips along watercourses had not been cut, hardwood forests had been selectively cut, and softwood stands had been clear-cut. Clear-cuts were from two to several hundred ha (5 to over 1,000 ac) in size. Other forests had been partially harvested, and the remainder had not been disturbed. Conclusive results showed that although moose used commercially clear-cut forests more than expected, the use was concentrated in 12-15-yr-old clear-cuts. Use of clear-cuts was proportionately less in mid winter after snow had become 60-70 cm (24-28 in) deep than in early winter. Moose used islands of softwoods within clear-cuts for cover and rest in early winter. Most moose beds occurred in islands larger than 2 ha (5 ac). The distribution of clear-cut, forage-producing areas and uncut areas for shelter in the commercially clear-cut unit (50% clear-cut, 25% selectively cut, 21% uncut, 4% roads and bogs) was ideal for moose (see also Peek 1976). In contrast, partial-stand harvesting resulted in a more homogenerous habitat with less browse for moose.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc.

Mould, E.D. 1977. Movement patterns of moose in the Colville River area, Alaska. M.S. Thesis, Univ. Alaska, Fairbanks, AK. 82 pp. (UAF)*

In this field research report, moose of all life stages were observed along the Colville River near Umiat, Alaska, at irregular intervals during all seasons of the year from July 1975 to November 1976. Habitat types included tall and low shrub stands along rivers, low shrub stands along intermittent streams, and open herbaceous tundra habitat. During the study, moose were harassed by aircraft, snowmobiles, and humans on foot. Moose reacted visibly to aircraft only when repeated passes were made at or below 50 m (164 ft) and reacted more frequently when in open terrain. Two moose bedded in dense cover remained motionless as snowmachines passed within 20 m (66 ft). When approached by a human on foot, moose in open tundra fled at distances of 700 m (2,296 ft) or more and never allowed approach closer than 200 m (660 ft). In shrub cover, maximum flight distance was less than 100 m (328 ft), and it was often possible to approach to 50 m (164 ft).

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Murie, A. 1934. The moose of Isle Royale. Univ. Mich. Press 44 pp. (ADF&G-F)

In this field research article, the biology of moose of all life stages on Isle Royale, Michigan, was studied throughout the summer between May and October 1930. Although the study area is south of Alaska, the habitat types of boreal forest conifers, birch, and aspen, including muskeg areas and lakes, are similar, as is the northern continental climate. Salt blocks had been set out to create artificial licks or to supplement natural licks, and the author approached moose to make observations. Moose were habituated to human presence in the absence of hunting, sometimes walking away at unstated distances, at other times apparently indifferent. Moose were attracted to artificial salt licks throughout the summer, including during the rut. Yearlings, bulls, and cows were seen at licks, but calves were left in hiding. Moose remained at a salt block as long as 3 h at a time.

Activity: chemical application; human disturbance.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Mytton, W.R., and L.B. Keith. 1981. Dynamics of moose populations near Rochester, Alberta, 1975-1978. Can. Field-Nat. 95(1):39-49. (GD)#*

In this field research report, a moose population including animals of all ages and both sexes was studied from October 1975 to April 1978 near Rochester, Alberta. Habitat types included aspen and conifer stands in uplands and lowland agricultural areas and wetlands, comparable to moose habitat in Alaska. The activities of human disturbance (associated with other unstated activities) and grading/plowing were responsible for documented direct impacts of passive harassment and vegetation damage/-destruction due to mechanical removal or material overlay. From December into March, moose moved to aspen and conifer stands away from human disturbance. During the last week of March and first week of April, there was a marked shift into lowland agricultural areas. February and March were the only months when moose were not located further from human disturbances than would be expected in a random distribution. The percentage of moose having about 1/3 or more cleared land within a 1 km (0.6 mi) radius of their location increased from 17% in November to 48% in March. Most moose did not tolerate areas of greater than 30% cleared land for extended periods. During spring (25 March-7 April), movements away from disturbance occurred when snow depths decreased. The mean distance to disturbance increased through spring and summer (1.2 km [0.75 mi] in April, 1.5 km [0.94 mi] in August) and then decreased in mid September with the onset of rut.

Activity: grading/plowing; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Parker, G.R., and I.D. Morton. 1978. The estimation of winter forage and its use by moose on clearcuts in northcentral Newfoundland. J. Range Manage. 31(4):300-304. (UAF)#*

This study was designed to evaluate the effect of clear-cutting on a moose (Alces alces americana) population in northcentral Newfoundland. Fourteen logged areas of various sizes and ages were sampled for potential standing forage and current use. Balsam fir (Abies balsamea), white birch (Betula papyrifera), pin-cherry (Prunus pennsylvanica), and willow (Salix spp.) were the most common forage species. Moose browsed most heavily upon pin-cherry, followed by birch and willow. Balsam fir was only lightly used. The most efficient-sized plot for measuring browse production was found to be 6 m^2 (65 ft^2). Available browse on balsam fir trees less than 5 m (16.4 ft) in height was measured by linear correlation with the product of stem diameter and height. Most winter browse was in cuts 8 to 10 yr of age. The greatest use was in cuts 8 to 10 yr of age. The greatest use was in cuts 40 to 50 ha (100-125 ac) in size. Impacts to moose occurred from the time of cutting until browse had regenerated at about 8 yr of age. In cuts greater than about 50 ha (125 ac), lack of mature forest cover nearby resulted in impacts persisting beyond 10 yr. A forest management plan that encourages a heterogeneous pattern of 40 to 50 ha (100-125 ac) block cuts and mature forest cover is suggested to be most compatible with the management of moose in southcentral Newfoundland. Logging in accordance with such a management plan can be beneficial to moose.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species.

Peek, J.M., D.L. Urich, and R.J. Mackie. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildl. Mono. 48. 65 pp. (ADF&G)#*

This study deals with moose population characteristics and relationships to forest management and habitat in northeastern Minnesota. Moose densities averaged about 0.77 moose/km^2 (1.97 moose/mi^2), with 1.93/km^2 (4.94/mi^2) existing on a large, recently logged area. Moose moved to dense conifer when snow depths were 46 cm or more. Moose used the open cutover areas of least cover and most abundant forage supplies in June and early winter. Dense conifer cover was preferred mid-winter bedding cover and was used commonly during severe winter periods for feeding. Impacts to moose occur after logging unless uncut areas are retained for cover and feeding in winter. Lowland communities were preferred habitats except during midwinter, when uplands were preferred. Logging activities on over 21% of the study area during 1948-1967, which created large fields of palatable browse species used by moose in June, November, and December, appeared to be the prime reason that a high moose population existed on the study area. Clear-cutting of large areas up to 81 or more ha (202.5 ac) in size appeared desirable to create large quantities of palatable shrub communities. The future of the moose population in this area depends upon logging and the successful reintroduction of fire.

Activity: burning; clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species.

Phillips, R.L., W.E. Berg, and D.B. Siniff. 1973. Moose movement patterns and range use in northwestern Minnesota. J. Wildl. Manage. 37(3):266-278. (UAF)

In this field research report, movements of moose of all life stages were studied from December 1968 through December 1971 in northwestern Minnesota. Although the study area is located at a more southerly latitude than Alaska, the climate is similar and results in comparable habitat types: marsh and open water, riparian successional willow stands, mature willow stands, forests of aspen and conifers, and cultivated fields. Hardwood forests also occur. The activities of clearing, draining, grading/plowing, and transporting personnel/equipment/material by land were responsible for the documented direct impact of barriers to movement and the indirect impacts of vegetation damage or destruction due to mechanical removal and vegetation composition change to less preferred or useable species or successional stage. Boundaries of moose home ranges in some cases appeared to be roads and ditches, tentatively implicating those as partial barriers. Areas of mature willow and aspen resulting from regrowth on cleared and drained farms conclusively provided late winter habitat, although they lacked abundant browse.

Activity: clearing and tree harvest; draining; grading/plowing; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Preston, D.J. 1983a. Moose habitat in areas of ongoing and proposed agricultural developments and moose populations in areas of ongoing and proposed agricultural developments. ADF&G, Fed. Aid in Wildl. Rest. Final rept. * Projs. W-21-2 and W-22-1, Jobs 1.34R and 1.35R. Juneau. 17 pp. (HD)

Aerial photos, ground surveys, and aerial surveys were used to map an 816 km^2 (319 mi^2) area of Interior Alaska near Delta Junction into habitat types. The study was conducted from July 1, 1980, through June 30, 1982. Major habitat types in the study area are agricultural land, coniferous and mixed forests, and shrubland. The study area includes long-established agricultural areas, recently developed agricultural projects, and undeveloped agricultural projects. Cleared and cultivated agricultural land comprises 35% of the study area and will increase to 46% by 1985 if the clearing of new agricultural areas progresses as scheduled.

During early winter 1981 and late winter 1982, aerial surveys were made to determine habitat selection by moose (Alces alces) in all life stages. Activities responsible for documented impacts were clearing and fencing of land. Conclusive results showed that moose avoided (p less than .05) cleared and cultivated agricultural land and coniferous forest throughout the winter and selected (p less than .05) deciduous/mixed forest and shrubland in early winter and shrubland in late winter. Current agricultural land provides very little moose habitat because berms and windrows cover only 1 to 3% of the land, are narrow, and are being burned and removed. In addition to indirect impacts of destruction of shrubland and deciduous/mixed forest by mechanical removal or fire, direct impacts due to attraction to an artificial food source (vegetable garden), entanglement in fences, and increased harvest were confirmed. The first two, as well as the latter, resulted in increased mortality to moose. Of the variety of types of fencing used, only barbed wire entangled moose. Fencing was discussed as a significant barrier to moose movements, but no conclusive data were presented. Damage to browse species in berms and windrows due to drift from application of herbicides was listed as a potential indirect impact.

Three mitigative measures were proposed. Corridors of forest vegetation at least 100 m (328 ft) wide should be left between large tracts in future agricultural projects to provide cover for moose movements. The ADF&G should compile fencing recommendations for farmers to minimize the hazards of barbed wire fencing to moose. Hunting may need to be restricted in the agricultural areas to prevent overharvest of moose.

[Reviewer's note: This is an excellent study of the effects of large-scale agriculture on moose in Alaska.]

Activity: burning; clearing and tree harvest; fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; entanglement in fishing nets, marine or terrestrial debris, or structures; harvest, change in level; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Preston, D.J. 1983b. The impacts of agriculture on wildlife. ADF&G, Fed. Aid in Wildl. Rest. Final rept. (Research) Projs. W-21-2 and W-22-1, Job 18.6R. Juneau. 143 pp. (ADF&G-F)*

In this review paper, the effects of agriculture on all life stages of a variety of wildlife species throughout North America are discussed. The following wildlife species and species groups featured in the Alaska Habitat Management Guide are included: swans, geese, ducks, several furbearers, brown bears, deer, moose, caribou, mountain goats, and Dall sheep. These species either occur in Alaska or are closely related to Alaskan species and are expected to respond similarly to agricultural activities. The 1,200 references cited range throughout the geographic areas and habitat types of North America. In most cases, the overall impacts of agriculture are independent of the specific location in which they were documented. The original studies were done throughout all seasons over the past several decades and were published primarily after 1970. Most of the impacts are discussed in terms of major wildlife species groups (e.g., birds, ungulates) and are not applicable to the species approach used in the AHMG. The few impacts identified as affecting moose, mountain sheep, and furbearers are summarized by species, followed by mitigation guidelines suggested for those impacts.

Moose. The activities of clearing and tree harvest and grading and plowing were responsible for the documented indirect impact of vegetation composition change, and the activity of grading and plowing was responsible for the documented direct impact of attraction to an artificial food source. Conclusive results were that 1,200-2,000 ha (3,000-4,000 ac) of good moose winter range were lost to the Delta agricultural project. Cultivated land is used less than other habitat types. Moose are attracted to gardens, especially in rural areas of Alaska. Mitigation recommendations are to protect crops by means of fencing designed to minimize entanglement of moose and by other nonlethal methods.

Sheep. The activity of grazing has been responsible for the documented direct impact of competition with or disease transmission from domestic species. Impacts were documented on bighorn sheep only, but effects on Dall sheep are expected to be similar. Livestock compete with bighorns for forage, and domestic sheep have transmitted three lethal diseases to bighorns: scabies mites, bluetongue virus (sampled for and found not to be present in Alaskan wildlife), and parainfluenza-3 virus (which causes pneumonia). The mitigation recommendation is to prohibit grazing livestock in or near (no distance stated) Dall sheep range.

Furbearers. The activities of grading and plowing and grazing were responsible for the documented direct impact of attraction to artificial food sources. The activity of fencing was responsible for the documented direct impact of barriers to movement and that of chemical application for the documented direct impact of mortality due to ingestion of chemicals. Squirrels are attracted to gardens, coyotes to domestic sheep, calves, and poultry, and wolves to sheep, calves and yearlings, and horses. Coyotes are

poisoned by chemical traps and by toxic collars on domestic sheep and are kept out of flocks of domestic sheep by deterrent, directing, or electric fences. Mitigation recommendations include restricting calving and lambing to easily monitored areas and disposing of livestock carcasses properly.

Deer. The activity of grading/plowing (growing crops) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. The activity of grazing was responsible for the documented direct impact of disease transmission from introduced domestic species. These impacts were documented on white-tailed and black-tailed deer, and effects on Sitka black-tailed deer are expected to be similar. Five strand high-tensile electric fencing successfully prevented deer that had been attracted to crops from entering fields or orchards and was not prohibitively expensive. Lethal epizootics of foot and mouth disease, bluetongue, and epizootic hemorrhagic disease have spread through deer populations in the contiguous 48 states after livestock transmitted the diseases to deer. Deer in Florida have also been infested by the cattle fever tick. In two documented cases, tens of thousands of deer were slaughtered to prevent reinfection of livestock. Recommendations are to actively implement existing disease regulations pertaining to importing livestock into Alaska and to monitor wildlife populations for exposure to livestock pathogens. Regulations require that imported livestock be free from disease.

Mountain goat. No impacts on mountain goats were documented in this paper.

An extensive subject index, including a taxonomic index to wildlife species, directs the reader to the references cited. Numerous other mitigation recommendations are made but are not directly supported by impacts documented on a stated wildlife species.

[Reviewer's note: This is an excellent, thorough review of the agricultural impact literature within and outside of Alaska. Not all references are applicable to Alaska, and impacts are not all documented in the sense used in the AHMG.]

Activity: clearing and tree harvest; grading/plowing.

Impact: attraction to artificial food source; vegetation composition, change to less preferred or useable species.

Rausch, R.A. 1958. The problem of railroad-moose conflicts in the Susitna Valley. ADF&G Fed. Aid in Wildl. Rest. Completion rept. Vol. 12, No. 1, Job No. 4. Distribution, movements, and dynamics of the railbelt moose populations. Juneau. 116 pp. (ADF&G-F)*

In this field research article, collisions of trains operating on the Alaska Railroad (ARR) with moose between January 1956 and December 1957 in the lower Susitna Valley, between Houston and Talkeetna, are discussed. Habitat types include boreal forests of white and black spruce, aspen, and birch, with balsam poplar, willow, and alder stands along rivers. Operation of passenger and freight trains, especially during periods of deep snow, was responsible for the documented direct impacts of barriers to moose movement (snow berms), collision of moose with trains, and entrapment of moose on the tracks between snow berms. Also, use of aircraft to census moose was responsible for the documented direct impact of active harassment. During the winters of 1955-56 and 1956-1957 respectively, 366 and 179 moose were killed by ARR trains, approximately 80% by passenger trains. Deterioration of winter range because of plant succession to birch forests throughout the area, and the presence of choice browse in more recently disturbed or burned areas along and adjacent to the railroad, combined with a healthy moose population and heavy snowfall, are the factors that result in the recurrent problem. Temporary expedients were tried in an attempt to decrease collision frequency. Sounding the horn at distances greater than 91.5 m (300 ft) confused or angered moose, which stayed on or returned to the tracks. Dimming or shutting off the headlight had no effect. Decreasing speed to less than 48 kph (30 mph) did decrease the number of kills, as did daylight operation of trains. Long-term solutions include providing winter browse away from the tracks and plowing alternate trails for moose. When actively harassed by light fixed-wing aircraft for population surveys at an unstated distance, cow moose with calves usually ran toward or faced in the direction of their calf. Temporary mitigative recommendations include the following: 1) solicit the cooperation of trainmen to report moose collisions and concentrations, and run aerial surveys of moose within 0.2 km (0.125 mi) along either side of the tracks. Issue temporary slow orders (less than 48 kph [30 mph]) for night trains through moose concentration areas; 2) operate trains through moose concentration areas only during daylight hours, when moose are bedded down; and 3) sound the train horn at distances of 91.5 m (300 ft) or less when moose are on the tracks. Long-term mitigative recommendations for keeping moose in winter concentration areas off the tracks include the following: 1) create large (e.g., 25.6 km^2 [10 mi^2]) areas of winter moose browse away from the tracks by burning or other means. Locating these to intercept and localize migration moose; 2) bulldoze trails parallel to the tracks, and bulldoze feed yards by knocking down aspen, birch, and willow trees adjacent to the trails (if this is done in November or early December, moose will keep trails open through use); and 3) use moose guards (like cattle guards) kept snowfree and with snow berms at either end to prevent moose from walking from bulldozed trails or access roads onto the tracks.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; entrapment in impoundments or excavations; harassment, active (hazing, chasing) or passive (noise, scent).

Rausch, R.A. 1965. Alaska wildlife investigations: moose studies. Fed. Aid in Wildl. Rest. Interim Rept. W-6-R-5,6. 116 pp. (GD)#

This report summarized data collected by ADF&G on the status of Alaskan moose populations. Data on productivity, movements, population composition, and mortality are presented. Mortality data include totals for moose killed by highway (202) and railroad (43) collisions between 1959 and 1965.

Activity: transport of personnel/equipment/material-land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Ruttan, R.A., and D.R. Wooley. 1974. A study of furbearers associated with proposed pipeline routes in the Yukon Territory and Mackenzie River valley, 1971. Arctic Gas Biol. Rept. Ser., Vol. 8. 118 pp. plus photos. (UAF)

All furbearers occurring in Alaska, with the exception of coyote, are discussed in this field research paper. Moose are also discussed. Field studies were conducted from June through November 1971 in arctic tundra and boreal forest habitat types in the Yukon Territory and Mackenzie River valley. Latitudes and habitat types are similar to those in Alaska, excepting Southeast and the Alaska Pennisula, where maritime influence predominates.

Furbearers. The activity of mechanical clearing leads to the potential direct impact of barriers to movement. Conclusive results of this study show the contrary, that fox, lynx, wolf, and wolverine often travel and forage along seismic lines and that marten and weasels cross them without hesitation. Documented indirect impacts include 1) alteration of the prey base, as ptarmigan were observed to favor open areas of seismic lines, especially where willows were regenerating; and 2) vegetation damage/destruction by mechanical removal and subsequent thermal erosion. Conclusive results show that in all but sphagnum bog and erosion areas natural revegetation was rapid. There was no significant difference in small mammal populations (food for carnivorous furbearers) between a disturbed and regenerated and an undisturbed area. Beaver established a pond where a seismic line crosses a creek. Also discussed in this paper are furbearer populations and habitat quality, and impacts on human use of furbearers.

Moose. Along with other large mammals, moose were observed to use seismic lines for foraging and travel during summer and in winter under shallow snow conditions.

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sigman, M.J., ed. 1985. Impacts of clearcut logging on the fish and wildlife resources of Southeast Alaska. ADF&G, Div. Habitat, Tech. Rept. 85-3. 95 pp. Juneau. (ADF&G-F)*

This review article discusses the effects of clear-cut logging on Sitka black-tailed deer, mountain goat, moose, brown and black bear, Bald Eagle, marten, mink, land otter, and red squirrel of all life stages, among other species. Most of the papers cited describe research done in Southeast Alaska since 1970, but older publications and studies performed on the same species in other geographic areas where the habitat types and latitude are similar to those of Southeast Alaska are also included. The studies were done at all seasons of the year. The habitat type is coastal temperate rain forest dominated by Sitka spruce, western hemlock, and other conifers. In addition to documented impacts, potential impacts are discussed, and life history and habitat use information is presented for each wildlife species. Only documented impacts and recommendations made in the cited papers are summarized below by species. Management recommendations made by the author are generalizations of those made in the cited papers and are not repeated here.

Sitka black-tailed deer. The activity of clearing and tree harvest was responsible for the documented direct impact of barriers to movement and for the documented indirect impacts of vegetation composition change to less preferred successional stage and vegetation damage or destruction due to mechanical removal. Dense shrubs and slash in clear-cuts less than 15 to 40 years old precludes deer movement and use in summer, and in winter higher snow depths in clear-cuts nearly prevent deer use and movement. Even in winters of little snow accumulation and in summer, deer avoid clear-cuts and prefer mature old-growth forest habitats. Precommercial thinning may prolong understory production in stands prior to canopy closure, but any effect is short-lived and a two-layered conifer stand results. Deer populations have declined by 50 to 75% after clear-cutting of areas on and near Vancouver Island, B.C. Mitigation recommendations are to burn slash or clear trails through it for deer, to cease disproportionate harvest of high-volume old-growth timber, and to avoid harvesting old-growth stands with exceptional fish and wildlife values.

Mountain goat. The activities of clearing and tree harvest and human disturbance were responsible for the documented direct impact of harassment. The activities of grading/plowing (road construction) and transporting personnel/equipment/material by land were responsible for the documented direct impacts of barriers to movement, harassment, and change in harvest level. Logging, logging camps and associated human noise, and vehicle traffic disturb goat behavior and cause abandonment of preferred high-quality summer range within and near the disturbances. The effects from logging camps have been documented within a 2 km (1.25 mi) radius and include increased mortality of goats. Construction of new roads has blocked goat movement and led to overharvest of previously less accessable populations. No recommendations based on documented impacts were made.

Moose. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. Although the high amount of forage in recent clear-cuts is beneficial to moose in areas of Southeast Alaska where riparian foreage is not abundant, as clear-cuts become dominated by young conifers moose cease using them. During periods of deep snow, moose do not use even recent clear-cuts but feed in high-volume old-growth and river terrace forests and in riparian shrub stands. Mitigation recommendations are to retain forests around and within high density feeding, breeding, and movement areas, and to retain any old growth river terrace forests or any other old-growth forest types that are limited in extent in the area of concern, as well as a portion of old-growth forests even if they are not limited in extent.

Furbearers. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. No impacts on wolves were documented, only on an important prey species included in the AHMG, Sitka black-tailed deer (q.v.). Populations of marten decline when mature coniferous forests are clear-cut, due to greatly decreased populations of red-backed voles, an important prey species, and due to loss of den sites in hollow trees and deadfalls. In winter, marten do not hunt in clear-cuts but only in dense, mature coniferous forest stands. They will cross but will not hunt in openings greater than 91 m (300 ft) in width. No mitigation recommendations were made for marten. Mink made almost no use of clear-cuts. Mitigation recommendations are to retain windfirm shoreline buffer strips at least 60 m (197 ft) inland from the shoreline. If shoreline forests must be clear-cut, keep the length of shoreline cut as short as possible, never more than 0.8 km (0.5 mi), and avoid cutting shoreline timber on points and in other areas where narrow timber stands separate shorelines, along intertidal zones where the distance between the 0 and +6 m (+20 ft) lines are less than 40 m (131 ft) apart, and along intertidal areas with high exposure of bedrock and boulder cover. Land otters avoid using clear-cuts for travel, burrows, or natal dens. Mitigation recommendations are to avoid logging adjacent to watercourses from early May to late summer (the breeding season) and to retain a windfirm fringe of forest 50 to 75 m (164 to 246 ft) wide along the beach to meet otter habitat requirements. Denning and feeding areas for red squirrels are eliminated by clear-cutting. Red squirrels cannot utilize clear-cuts until cone production by revegetating conifers is reestablished after 20 to 40 yr.

Brown bear. References reviewed for impacts to brown bear included studies conducted in coastal forests and studies conducted in interior forests (e.g., Montana). The activity of clearing and tree harvest produced documented impacts of changes in vegetation composition to less preferred successional stages (e.g., changing old growth to even aged forest), vegetation damage and destruction due to mechanical removal, barriers to movements (e.g., extensive areas of slash), and harassment. The activity of grading (road building) produced a documented direct impact of harassment.

The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source (i.e., garbage). The activity of human disturbance produced documented direct impacts of harassment and an increase in the harvest of bears (nuisance kills and increased access for hunters).

Bald Eagle. The activity of clearing and tree harvest produced a documented indirect impact of vegetation damage/destruction due to mechanical removal. Logging within 45 m (150 ft) of nest trees resulted in blowdown of nest trees at a rate 20 times more common than when logging occurred further than 45 m (150 ft) from the nest trees.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Somerville, R. 1965. The effects of changing land use on moose. Paper, Forestry 471, Spring. 31 pp. Mimeo. (HD)

This review paper includes information on moose of all ages and both sexes throughout their present and historic range in the northern hemisphere. The cited papers are dated from 1912 through 1964, with the majority written after 1946, including studies done during all seasons of the year. Habitat types include the boreal coniferous forest, arctic tundra with nonprostrate shrub cover, and montaine coniferous forest and alpine habitats of mountains extending south from the boreal forest. The activities of burning, clearing, and tree harvest, chemical application, draining, drilling, grading/plowing, transporting personnel/equipment/material by land, and water regulation/withdrawal are responsible for the documented direct impact of collision with vehicles and indirect impacts of vegetation change to less preferred or useable species or successional stage and vegetation damage/destruction due to mechanical removal or material overlay. A potential indirect impact is that of water level or water quality fluctuations. The effects of fire, sizes and type of logging cuts, active and abandoned farms, and the Alaska Railroad killing 150-300 moose annually in a 48 km (30 mi) stretch near Palmer are discussed in moderate detail, and the effects of herbicides, oil development, hydroelectric development, and draining are briefly mentioned. Mitigation is not discussed.

Activity: burning; chemical application; clearing and tree harvest; draining; drilling; grading/plowing; transport of personnel/equipment/material - land; water regulation/withdrawal/irrigation.

Impact: collision with vehicles or structures or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to air pollution or contact with petroleum products; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Sopuck, L.G., and D.J. Vernam. 1984. Late winter distribution and movements of moose in relation to the Trans-Alaska Pipeline in interior Alaska. Renewable Resources Consulting Services Ltd. March. xii + 92 pp. (ADF&G-F)*

In this field research report, moose of all ages and both sexes were studied during February and March of 1982 and 1983 along the Trans-Alaska Pipeline System (TAPS) right-of-way (ROW) between Eielson Air Force Base and Big Delta in interior Alaska. Habitat types included coniferous, mixed, and deciduous boreal forests; shrub, wetland, and riparian, and tundra communities; and recently burned or disturbed areas. The activities of grading/plowing and transport of oil by land were responsible for the direct, documented impact of barriers to movement and the potential impact of passive harassment. Conclusive results indicated that moose crossed the ROW at pipe heights of less than 1.5 m (5 ft) less often than expected and at heights of 2.4-2.7 m (8-9 ft) more often than expected. Because of the low percentage (6.6) of pipe heights less than 1.5 m (5 ft) in this area, the pipe had no significant impact on resident moose movements overall. Pipe heights greater than 3 m (10 ft), at Designated Big Game Crossings, were not used preferentially, nor were buried sections. Of moose approaching the ROW, 84% crossed within 25 m (82 ft), and 93% were known to have successfully crossed at some point. Moose distribution was independent of distance from the pipe, indicative of the absence of passive harassment. Moose distribution and pipe-crossing sites were associated with habitats providing abundant browse. Recommendations for future pipelines are as follows:

(1) Time construction activities for nonmigratory periods, and/or restrict barriers such as pipe on the ground and long, deep ditches to short sections to limit the temporal and spatial extent of barriers during construction.

(2) Conservatively maintain pipe heights, considering maximum snow depths (not addressed in this study during years of well-below-normal snowfall). However, because of the restriction of home ranges in years of heavy snowfall, moose movements across TAPS are not expected to be seriously affected.

(3) Special buried or elevated (above 3 m, 10 ft) pipe sections are not necessary to allow a high success rate for moose crossings.

[Reviewer's note: This is a well-documented, thorough study.]

Activity: grading/plowing; transport of oil/gas/water - land.

Impact: barriers to movement, physical and behavioral.

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: burning; clearing and tree harvest; draining; grading/plowing; human disturbance; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; entrapment in impoundments or excavations; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Stringham, S.F. 1971. Calf behavior and the cow-calf bond in moose. Alaska Coop. Wildl. Res. Unit, Q. Prog. Rept. 22(4):12-32. (UAF)*

In this field research report, the reactions of moose calves, yearlings, and cow-calf pairs to approaching humans on foot were observed in conjunction with behavioral studies of moose on the Kenai National Moose Range, Alaska, from May through August 1970. Habitat types included boreal forests and burned areas revegetating to willows and young trees. The activity of human disturbance was responsible for the direct documented impacts of active and passive harassment. Cows with newborn calves reacted aggressively to approach within an unstated distance. Cows with calves a few days to a week old responsed to approach of a human within 20 m (66 ft) with a mild threat and a retreat with the calf, even though cows rarely move with calves of this age when undisturbed. Over a period of a few weeks, cow and calf pairs became habituated to an observer and allowed approach to within 25 m. In one instance a habituated moose approached within 10 m of the observer voluntarily.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Telfer, E.S. 1974. Logging as a factor in wildlife ecology in the boreal forest. Forestry Chronicle 50(5):186-190. (UAF)*

In this informal review article, the effects of logging on several wildlife species, including moose of all life stages, in the boreal forest zone of North America and Europe are discussed. The papers cited were published between 1947 and 1973 and include studies done at all seasons of the year. Habitat types are limited to forest stands in the boreal zone, including coniferous species such as spruces and tamarack, and deciduous species such as aspen and birch. Such forest types are common in Alaska. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. Clear-cuts more than about 15 yr old no longer provide sufficient browse to act as preferred winter habitat. Natural wintering areas have been destroyed during clear-cutting of some forests. Clear-cuts larger than 1.3 km^2 (0.5 mi^2) are not fully utilized by moose until new cover develops after 15 yr or more. In Sweden, large, progressive clear-cuts covering about 20-30 km^2 (several mi^2) over a 20 yr period have resulted in a decrease in the moose population compared to that when smaller areas were being clear-cut. Selective cutting does not benefit moose unless the residual basal area is reduced to 17.2 m^2/ha (75 ft^2/ac) or less. Optimum wintering areas for moose are characterized by remnant mature forest on 19-46% of the area and disturbed openings averaging 97.1 ha (240 ac) as a well-dispersed patchwork, with most openings less than 1.3 km^2 (0.5 mi^2). No parts of the openings were more than 0.53 km (0.33 mi) from mature forest. Mitigation guidelines are to cut timber in strips less than 201.2 m (600 ft) wide and to wait at least 30 yr before cutting adjacent stands.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Tomm, H.O., J.A. Beck, Jr., and R.J. Hudson. 1981. Responses of wild ungulates to logging practices in Alberta. Can. J. For. Res. 11:606-614. (UAF)*

In this field research article, the effects of clear-cutting on moose of all life stages were studied in the boreal forest zone of west-central Alberta. White-tailed and mule deer were also studied. Neither the year nor the season during which the study was performed are stated. Although the study area is at a more southerly latitude than Alaska, the habitat types of forests of aspen, balsam poplar, paper birch, and white spruce on upland areas and black spruce and tamarack on wet sites are similar to those of interior Alaska, although other trees such as balsam fir and lodgepole pine are also present. The activity of clearing and tree harvest was responsible for the documented indirect impact of vegetation composition change, and the activities of clearing and tree harvest, grading of roads, human disturbance, and transporting personnel/equipment/material by land were responsible for the documented direct impact of harassment. Clear-cuts had revegetated for 2 to 9 yr after scarification, natural or artificial reseeding, or replanting. Harassment in areas sampled was estimated on a four-class scale from low (e.g., timber cruising, occasional hiking) to high (e.g., a road or ATV trail through the area, with weekend recreational use or regular logging use) without regard for specific sources of harassment. Moose used clear-cuts 16.6-32 ha (41-80 ac) in size most frequently, and use of larger clear-cuts was only slightly less. The width of uncut forest between the most frequently used clear-cuts was 221-402 m (726-1,320 ft). Harassment affected the distance from cover that moose would feed. Under low harassment, there was no difference in the degree of use from the edge of a clear-cut to 161 m (528 ft) or more into the clearcut. Under high harassment, use decreased below the average (expected) level at 60 m (198 ft) and reached a constant low level at 80-101 m (264-330 ft). Mitigation recommendations include the following: 1) to minimize harassment, control public access to logging roads (e.g., by closing roads); 2) in areas of low harassment, clear-cuts may be made up to 322-402 m (1,056-1,320 ft) wide; 3) in areas of high harassment, decrease the maximum width of clear-cuts to 121-161 m (396-528 ft); 4) in areas of low harassment, retain uncut buffers at least 101 m (330 ft) wide between clear-cuts, and increase this distance (to an unstated amount) in areas with high harassment; and 5) in areas of low harassment, clear-cuts may exceed 32.4 ha (80 ac). Recommendations for deer are also made and differ from those for moose.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation composition, change to less preferred or useable species.

Tracy, D.M. 1977. Reactions of wildlife to human activity along Mount McKinley National Park Road. M.S. Thesis, Univ. Alaska, Fairbanks. xxii + 260 pp. (UAF)*

In this thesis based on field research, moose, Dall sheep, and several furbearers, including red fox, wolf, and lynx, at all life stages and of both sexes were observed during mid May through September of 1973 and 1974 along and adjacent to the road through Mount McKinley National Park. Habitat types include subalpine white spruce forests, tall and low shrub stands, alpine tundra, and wetland and riparian vegetation. The activities of human disturbance and transport of personnel/equipment/material by land were responsible for direct, documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, active and passive harassment, interference with reproductive behavior, alteration of prey base, and vegetation composition change.

Moose. Conclusive results showed that moose did not avoid watersheds traversed by the road. At distances greater than 300 m (984 ft) from the road, moose rarely reacted to human disturbance along the road. At distances less than 200 m (656 ft), loud noises and people quietly getting off busses increased passive harassment by two to three times. Young calves stumbled or rolled down a bank when surprised by hikers or vehicles. Habituation of some moose to moderate disturbances occurred over the course of the summers. Although at distances of less than 200 m (656 ft) only half of the moose showed visible responses to road disturbance, responses such as staring then slowly moving into cover while browsing were not recorded. Willows revegetating cleared roadsides may occasionally attract moose, and one moose was killed by a vehicle collision during this study.

Dall Sheep. Conclusive results show that Dall sheep became habituated to photographers, allowing approaches on foot to within 100 m (328 ft). Some sheep have become habituated to crossing the road between summer and winter range in the presence of people and vehicles, while the movements of others are inhibited by the road. Within 200 m (656 ft) of the road, 32% of sheep showed strong responses to buses and visitors, while no strong responses were noted beyond 400 m (1,312 ft). The percentage of strong responses within 200 m (656 ft) increased from busses passing through to busses stopping to people getting out, and was greatly increased by loud noises. Tentatively, since use of the range where the road runs through sheep habitat was much greater in the past, disturbance may have resulted in abandonment of the range by most sheep.

Furbearers. Conclusive results showed that red fox also did not avoid the vicinity of the road, for hunting or denning. Foxes more than 100 m (328 ft) from the road rarely responded strongly to disturbance, but mild responses were observed to 600 m (1,968 ft). Habituation to disturbance readily occurs. Foxes hunt and travel along the road, and are sometimes fed by visitors.

Wolves use the road for travel, especially in winter when it is closed, scavenge road kills, and become beggars when fed by visitors. Wolves are infrequently strongly disturbed while killing or feeding within 200 m (656 ft) of the road.

Lynx, on the three occasions sighted, showed only mild reactions to vehicles on the road 200 m (656 ft) away and to a quiet human 100 m (328 ft) away.

Hares, prey for several furbearers, were attracted to roadside artificial and natural revegetation, the latter in early spring and the former during the summer. A man-made mineral lick along the road also attracted hares.

> Activity: human disturbance; transport of personnel/equipment/material - land.
>
> Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

USDI. 1976a. Alaska natural gas transportation system - final environmental impact statement. Washington, D.C. (ARL)#*

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.
2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.
3) Muskoxen may have shifted their traditional summer range by 25.6 km (16 mi) in response to heavy helicopter traffic.
4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.
5) Muskoxen and Canadian geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.
2) Caribou can apparently tolerate winter blasting if they are not hunted.
3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.
4) Waterfowl with young avoid drilling rigs within a 4.3 km (2-2/3 mi) radius.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Van Ballenberghe, V. 1978. Final report on the effects of the trans-Alaska pipeline on moose movements. Special Rept. No. 23, Joint State/Federal Fish and Wildlife Advisory Team. 41 pp. (UAF)*

In this field research report, the movements of moose of all life stages were studied along the trans-Alaska pipeline in the eastern Nelchina Basin between Glennallen and Paxson throughout the year from October 1974 through June 1977. Habitat types included black spruce forests, subalpine shrub tundra and alpine tundra, and riparian zones with willows and balsam poplar. The activities of grading/plowing and transport of oil by land resulted in the documented direct impact of barriers to movement. Conclusive results showed that moose did not cross the 3 m (10 ft) or more deep ditches opened for burial of the pipe. Moose also did not cross the elevated pipe when the vertical clearance was 1.2 m (4 ft) or less. Under shallow snow conditions 25 cm (10 in) or less, a vertical distance of 1.5 m (5 ft) is the practical lower limit for potential moose-crossing sites, and nearly 60% of all crossings occurred where the vertical distance was between 1.8 and 2.4 m (6 and 8 ft). Movements of 16% of moose approaching the pipeline were deflected, but only 3% were not known to have crossed successfully at another point, almost always where the pipe was higher. Snow depths in excess of 76 to 102 cm (30-40 in) from November or December through spring, which occur rarely, would be expected to result in significant blockage of moose migration by the pipe. Recommendations include the following: 1) maximum length of pipe sections that block moose movement should not exceed 0.8 km (0.5 mi); 2) such sections should not be built during migration periods; and 3) when such sections are created during construction, they should be removed (buried or elevated) as soon as possible.

Activity: grading/plowing; transport of oil/gas/water - land.

Impact: barriers to movement, physical and behavioral.

Vinogradov, V.V., and S.I. Chernyavskoya. 1976. Changes in the habitat conditions of animals in the Volga Delta associated with the implementation of the Volgograd hydroelectric station. Byull Mosk. O-Va. Ispyt. Prir. Otd. Biol. 81(1):136-138. #(Library not stated in Southwest citation).

In this article, various animal species in the Volga Delta, USSR, are discussed. The animal species and life stages, dates of study, type of study, and most habitat types involved were not stated in the Southwest Guide annotation. The activity of water regulation/withdrawal by the Volgograd dam, completed in 1958, resulted in indirect, documented impacts of vegetation composition change to less preferred or useable species and water level or water quality fluctuations. Vastly reduced alluvial deposits slowed the formation of new islands and spits, which had previously become vegetated by highly productive white willow associations. After 20 yr, the reproducing ability of the willow declined, and a less productive reed-grass association replaced the willow. Detailed effects on animal species are not mentioned in the Southwest Guide annotation.

Activity: water regulation/withdrawal/irrigation.

Impact: vegetation composition, change to less preferred or useable species; water level or water quality fluctuations.

Wooley, D.R. 1976. Terrestrial mammal studies along the cross delta pipeline route, 1975. Chapter 3, pages 1-48, in R.D. Jakimchuk, ed. Studies of mammals along the proposed MacKenzie Valley gas pipeline route, 1975. Arctic Gas Biol. Rept. Ser., Vol. 36. Prepared by Renewable Resources Consulting Services Ltd. for Canadian Arctic Gas Study, Ltd. and Alaskan Arctic Gas Study Co. (UAF)

In this field research report, the effect of opening a road on moose of all life stages in the southern MacKenzie River delta, Northwest Territories, Canada, was observed during July and November 1975. The latitude of the study area is the same as that of Alaska, and the habitat types of riparian white spruce stands, willow thickets, and muskeg areas above the floodplain are the same as those in Alaska. The activity of opening the Dempster Highway was responsible for the documented direct impact of an increase in level of harvest. A river floodplain area had supported a locally high moose population in a restricted area of willow stands. After the highway greatly improved hunter access, conclusive results were that several moose were known from harvest records to have been taken out of the area, and no moose were seen during subsequent surveys. It was expected that the local population of moose was extirpated or seriously reduced.

Activity: transport of personnel/equipment/material - land.

Impact: harvest, change in level.

14. Sitka Black-tailed Deer

Table 1. Impacts Associated With Each Activity - Blacktailed deer

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source				X	X							X													?			X		
Barriers to movement, physical and behavioral			?		X		?		X			X		X				?	X						?			X		X
Collision with vehicles or structures					X																							X		
Entanglement in fishing nets, debris					?				X																					
Entrapment in impoundments or excavations												?										?						?		X
Harassment, active or passive	X				X		?	?		?	?	X	X	X	?		?	?	?	?	?	?			?		X	X		
Harvest, change in level			X		?		?	?				X		X				?	?						?			X		
Introduced wild/domestic species, competition													X	X																
Morbidity/mortality by ingestion of petroleum				X				?												?					?	?				
Parasitism/predation, increased susceptibility					X									X																
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction	?										?	?			?							?								
Veg. composition, change to less preferred				X	X							?	X																	
Veg. damage/destruction due to air pollution				X															?	?										
Veg. damage/destruction due to fire/parasitism																														
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion					X						?	X				?				?		?								
Water level or water quality fluctuations														?							?				?	?				X

X - Documented impact (see text).
? - Potential impact.

14. SITKA BLACK-TAILED DEER - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on Sitka black-tailed deer. Each citation refers to an annotation in the following section, Annotated References to Impacts on Sitka Black-tailed Deer. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to Sitka black-tailed deer are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to Sitka blacktailed deer were found for the following activities:

- Burning
- Draining
- Dredging
- Drilling
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Log storage/transport
- Netting
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing oil/gas
- Sewage disposal
- Solid waste disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - land, ice
- Transport of oil/gas/water - water

Activities definitions and the list of impacts categories are located in Appendix C and E, respectivelv.

1. Blasting:

    a. Harassment, active or passive

        Kvale 1980

2. Channelizing waterways:

   a. Harvest, change in level

      Simpson et al. 1982

3. Chemical application:

   a. Attraction to artificial food source

      Taber and Hanley 1979

   b. Morbidity/mortality by ingestion of petroleum

      Case and Murphy 1962

   c. Veg. composition, change to less preferred

      Taber and Hanley 1979

   d. Veg. damage/destruction due to air pollution

      Beasom and Scifres 1977
      Caslick and Decker 1978
      Hill 1977?
      McAninch et al. 1983
      Merriam 1971
      Taber and Hanley 1979
      Wingard and Palmer 1982

4. Clearing and tree harvest:

   a. Attraction to artificial food source

      Sopuck et al. 1979

   b. Barriers to movement, physical and behavioral

      Hanley 1984
      Harris and Farr 1979
      Millar 1983
      Parker et al. 1984
      Regelin 1979
      Schoen and Wallmo 1979
      Sigman 1985
      Sopuck et al. 1979

   c. Collision with vehicles or structures

Millar 1983

d. Harassment, active or passive

Eckstein et al. 1979
Loft et al. 1984
Sopuck et al. 1979

e. Parasitism/predation, increased susceptibility

Schoen et al. 1983

f. Veg. composition, change to less preferred

Billings and Wheeler 1979
Hanley 1984
Harestad et al. 1982
Harris and Farr 1979
Jones 1974
Loft et al. 1984
Regelin 1979
Schoen and Kirchhoff 1983
Schoen and Wallmo 1979
Schoen et al. 1983
Sigman 1985
Sopuck et al. 1979
Taber and Hanley 1979
Wallmo and Schoen 1980

g. Veg. damage/destruction due to erosion

Billings and Wheeler 1979
Hanley 1984
Harestad et al. 1982
Harris and Farr 1979
Jones 1974
Kirchhoff et al. 1982
Michael 1978
Millar 1983
Regelin 1979
Schoen and Kirchhoff 1983
Schoen and Wallmo 1979
Schoen et al. 1982
Schoen et al. 1983
Sigman 1985
Smith 1979
Sopuck et al. 1979
Taber and Hanley 1979
Vogel 1983
Wallmo and Schoen 1980

5. Fencing:

   a. Barriers to movement, physical and behavioral

      Caslick and Decker 1978
      Hauge 1985
      Hill 1977?
      Jepson et al. 1983
      Kinsey 1976
      Kvale 1980
      McAninch et al. 1983
      Porter 1982
      Preston 1983b
      Stuht 1985
      Wingard and Palmer 1982
      Young 1955?

   b. Entanglement in fishing nets, debris

      Jepson et al. 1983

6. Grading/plowing:

   a. Attraction to artificial food source

      Carbaugh et al. 1975
      Caslick and Decker 1978
      Hill 1977?
      Kinsey 1976
      McAninch et al. 1983
      Porter 1982
      Preston 1983b
      Sopuck et al. 1979
      Vogel 1983
      Wingard and Palmer 1982

   b. Barriers to movement, physical and behavioral

      Kvale 1980
      Millar 1983

   c. Harassment, active or passive

      Sopuck et al. 1979

   d. Harvest, change in level

      Ellis et al. 1978

e. Veg. damage/destruction due to erosion

Kvale 1980
Michael 1978
Millar 1983
Smith 1979
Vogel 1983

7. Grazing:

a. Harassment, active or passive

Hood and Inglis 1974
Sopuck et al. 1979

b. Introduced wild/domestic species, competition

Anderson 1962
Campbell and Johnson 1983
Holechek et al. 1982
Hood and Inglis 1974
Klebesadel and Restad 1981
Longhurst and Douglas 1953
Preston 1983b
Skovlin and Harris 1970
Skovlin et al. 1968
Smith 1979

c. Veg. composition, change to less preferred

Skovlin and Harris 1970

d. Veg. damage/destruction due to grazing

Holechek et al. 1982
Young 1955?

8. Human disturbance:

a. Barriers to movement, physical and behavioral

Kvale 1980
Sopuck et al. 1979
Vogel 1983

b. Harassment, active or passive

Altmann 1958

Anderson 1979
Behrend and Lubeck 1968
Bollinger et al. 1973
Eckstein et al. 1979
Freddy et al. 1986
Geist 1971a
Hood and Inglis 1974
Kvale 1980
Loft et al. 1984
Parker et al. 1984
Richens and Lavigne 1978
Smith 1979
Sopuck et al. 1979
Vogel 1983

c. Harvest, change in level

Anderson 1979
Vogel 1983

d. Introduced wild/domestic species, competition

Geist 1971a

e. Parasitism/predation, increased susceptibility

Anderson 1979
Smith 1979
Sopuck et al. 1979
Vogel 1983

9. Processing minerals (including gravel):

a. Barriers to movement, physical and behavioral

Kvale 1980

10. Transport of personnel/equipment/material - air:

a. Harassment, active or passive

Krausman et al. 1986

11. Transport of personnel/equipment/material - land, ice:

a. Attraction to artificial food source

Sopuck et al. 1979

b. Barriers to movement, physical and behavioral

Greenwood and Dalton 1984
Kvale 1980
Millar 1983
Reed et al. 1975
Sopuck et al. 1979

c. Collision with vehicles or structures

Anderson 1979
Carbaugh et al. 1975
Millar 1983
Sopuck et al. 1979
Vogel 1983

d. Harassment, active or passive

Bollinger et al. 1973
Dorrance et al. 1975
Eckstein et al. 1979
Freddy et al. 1986
Greenwood and Dalton 1984
Loft et al. 1984
Millar 1983
Moen et al. 1982
Richens and Lavigne 1978
Rost and Bailey 1979
Sopuck et al. 1979
Vogel 1983

e. Harvest, change in level

Ellis et al. 1978
Geist 1971a
Sopuck et al. 1979

12. Transport of personnel/equipment/material - water:

a. Harassment, active or passive

Loft et al. 1984

13. Water regulation/withdrawal/irrigation:

a. Barriers to movement, physical and behavioral

Loft et al. 1984

b. Entrapment in impoundments or excavations

Loft et al. 1984

c. Water level or water quality fluctuations

Loft et al. 1984

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to Sitka black-tailed deer were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Terrain alteration or destruction
Veg. damage/destruction due to fire/parasitism

Activities definitions and the list of impacts categories are located in Appendix C and E, respectively.

1. Attraction to artificial food source:

   a. Chemical application

      Taber and Hanley 1979

   b. Clearing and tree harvest

      Sopuck et al. 1979

   c. Grading/plowing

      Carbaugh et al. 1975
      Caslick and Decker 1978
      Hill 1977?
      Kinsey 1976
      McAninch et al. 1983
      Porter 1982
      Preston 1983b
      Sopuck et al. 1979
      Vogel 1983
      Wingard and Palmer 1982

   d. Transport of personnel/equipment/material - land,ice

      Sopuck et al. 1979

2. Barriers to movement, physical and behavioral:

   a. Clearing and tree harvest

Hanley 1984
Harris and Farr 1979
Millar 1983
Parker et al. 1984
Regelin 1979
Schoen and Wallmo 1979
Sigman 1985
Sopuck et al. 1979

b. Fencing

Caslick and Decker 1978
Hauge 1985
Hill 1977?
Jepson et al. 1983
Kinsey 1976
Kvale 1980
McAninch et al. 1983
Porter 1982
Preston 1983b
Stuht 1985
Wingard and Palmer 1982
Young 1955?

c. Grading/plowing

Kvale 1980
Millar 1983

d. Human disturbance

Kvale 1980
Sopuck et al. 1979
Vogel 1983

e. Processing minerals (including gravel)

Kvale 1980

f. Transport of personnel/equipment/material - land, ice

Greenwood and Dalton 1984
Kvale 1980
Millar 1983
Reed et al. 1975
Sopuck et al. 1979

g. Water regulation/withdrawal/irrigation

Loft et al. 1984

3. Collision with vehicles or structures:

   a. Clearing and tree harvest

      Millar 1983

   b. Transport of personnel/equipment/material - land, ice

      Anderson 1979
      Carbaugh et al. 1975
      Millar 1983
      Sopuck et al. 1979
      Vogel 1983

4. Entanglement in fishing nets, debris:

   a. Fencing

      Jepson et al. 1983

5. Entrapment in impoundments or excavations:

   a. Water regulation/withdrawal/irrigation

      Loft et al. 1984

6. Harassment, active or passive:

   a. Blasting

      Kvale 1980

   b. Clearing and tree harvest

      Eckstein et al. 1979
      Loft et al. 1984
      Sopuck et al. 1979

   c. Grading/plowing

      Sopuck et al. 1979

   d. Grazing

      Hood and Inglis 1974
      Sopuck et al. 1979

e. Human disturbance

Altmann 1958
Anderson 1979
Behrend and Lubeck 1968
Bollinger et al. 1973
Eckstein et al. 1979
Freddy et al. 1986
Geist 1971a
Hood and Inglis 1974
Kvale 1980
Loft et al. 1984
Parker et al. 1984
Richens and Lavigne 1978
Smith 1979
Sopuck et al. 1979
Vogel 1983

f. Transport of personnel/equipment/material - air

Krausman et al. 1986

g. Transport of personnel/equipment/material - land,ice

Bollinger et al. 1973
Dorrance et al. 1975
Eckstein et al. 1979
Freddy et al. 1986
Greenwood and Dalton 1984
Loft et al. 1984
Millar 1983
Moen et al. 1982
Richens and Lavigne 1978
Rost and Bailey 1979
Sopuck et al. 1979
Vogel 1983

h. Transport of personnel/equipment/material - water

Loft et al. 1984

7. Harvest, change in level:

a. Channelizing waterways

Simpson et al. 1982

b. Grading/plowing

Ellis et al. 1978

c. Human disturbance

Anderson 1979
Vogel 1983

d. Transport of personnel/equipment/material - land, ice

Ellis et al. 1978
Geist 1971a
Sopuck et al. 1979

8. Introduced wild/domestic species, competition:

a. Grazing

Anderson 1962
Campbell and Johnson 1983
Holechek et al. 1982
Hood and Inglis 1974
Klebesadel and Restad 1981
Longhurst and Douglas 1953
Preston 1983b
Skovlin and Harris 1970
Skovlin et al. 1968
Smith 1979

b. Human disturbance

Geist 1971a

9. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Case and Murphy 1962

10. Parasitism/predation, increased susceptibility:

a. Clearing and tree harvest

Schoen et al. 1983

b. Human disturbance

Anderson 1979

Smith 1979
Sopuck et al. 1979
Vogel 1983

11. Veg. composition, change to less preferred:

a. Chemical application

Taber and Hanley 1979

b. Clearing and tree harvest

Billings and Wheeler 1979
Hanley 1984
Harestad et al. 1982
Harris and Farr 1979
Jones 1974
Loft et al. 1984
Regelin 1979
Schoen and Kirchhoff 1983
Schoen and Wallmo 1979
Schoen et al. 1983
Sigman 1985
Sopuck et al. 1979
Taber and Hanley 1979
Wallmo and Schoen 1980

c. Grazing

Skovlin and Harris 1970

12. Veg. damage/destruction due to air pollution:

a. Chemical application

Beasom and Scifres 1977
Caslick and Decker 1978
Hill 1977?
McAninch et al. 1983
Merriam 1971
Taber and Hanley 1979
Wingard and Palmer 1982

13. Veg. damage/destruction due to grazing:

a. Grazing

Holechek et al. 1982
Young 1955?

14. Veg. damage/destruction due to erosion:

a. Clearing and tree harvest

Billings and Wheeler 1979
Hanley 1984
Harestad et al. 1982
Harris and Farr 1979
Jones 1974
Kirchhoff et al. 1982
Michael 1978
Millar 1983
Regelin 1979
Schoen and Kirchhoff 1983
Schoen and Wallmo 1979
Schoen et al. 1982
Schoen et al. 1983
Sigman 1985
Smith 1979
Sopuck et al. 1979
Taber and Hanley 1979
Vogel 1983
Wallmo and Schoen 1980

b. Grading/plowing

Kvale 1980
Michael 1978
Millar 1983
Smith 1979
Vogel 1983

15. Water level or water quality fluctuations:

a. Water regulation/withdrawal/irrigation

Loft et al. 1984

ANNOTATED REFERENCES TO IMPACTS TO SITKA BLACK-TAILED DEER

The annotated bibliography contains only references that discuss documented impacts to Sitka black-tailed deer. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to Sitka black-tailed deer are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Altmann, M. 1958. The flight distance in free-ranging big game. J. Wildl. Manage. 22(2):207-209. (UAF)*

In this field research article, the responses of moose of all life stages to a human on foot in Wyoming (specific location(s) not given) during all seasons of a three-year period (years not stated) were determined. Brief observations of elk and mule deer were also made. The geographic area is located south of Alaska, but the high elevation of the study location results in habitat types similar to those utilized by moose in Alaska: coniferous and aspen forests, riparian zones, and moist meadows. The activity of human disturbance was responsible for the direct documented impacts of active and passive harassment. Conclusive results showed that the flight distance (the distance to which a person can approach a wild animal without causing it to flee) for moose is variable, depending upon the season, habitat type, and the specific experience of an animal or group. Short flight distances 3-27.5 m (10-90 ft) were characteristic of cows with new calves, prerutting bulls, both sexes during the rut (except when hunted), winter groups, and feeding in water, whereas long distances 30.5-61 m (100-200 ft) were characteristic of cows with heeling calves and bulls in velvet. The flight distance of both sexes became very long 61-91.5 m (200-300 ft) during hunting season. Flight distance was also shorter for habituated moose, in dense vegetation, and at dusk and dawn. The latter was also true for deer and elk.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Anderson, R.C. 1962. The parasites (helminths and arthropods) of white-tailed deer. Pages 162-173 in L.E. Foote, chairman, Proceedings of the first national white-tailed deer disease symposium, February 13-15. Univ. Georgia, Athens, GA. 202 pp. (HD)*

In this review article, reports of parasites of white-tailed deer of all life stages were compiled throughout the geographic range of the species. Relevant observations were published between 1943 and 1961 and were made at various seasons of the year. Although the geographic areas (primarily in the lower 48) and associated habitat types are not comparable to those used by Sitka black-tailed deer in Alaska, susceptibility of black-tailed deer to parasites of domestic livestock is expected to be similar do that of white-tailed deer. The introduction of domestic sheep carrying the trichostrongylene nematode Dicrocoelium dendriticum to North America was responsible for the documented direct impact of establishment of the parasite in deer, which are now considered a reservoir species. Six trichostrongyle species were similarly transferred from livestock to deer on ranches in Texas in the 1940's. Mitigative guidelines include the following: 1) avoid overpopulation of deer and deterioration of browse so that parasite transmission by chance encounters or among deer forced to graze is decreased, and so that deer in vigorous condition can resist parasites; 2) eradicate parasites from livestock and, if localized, from deer herds; and 3) ensure a proper balance between livestock and deer sharing the same range.

Activity: grazing

Impact: introduced wild or domestic species, competition with or disease transmission from.

Anderson, D.T. 1979. The effect of dog harassment on translocated white-tail deer (<u>Odocoileus virginianus virginianus</u>) on the Cumberland Plateau in Tennessee. Tenn. Wildl. Resour. Agency Tech. Rept. No. 79-8, Fed. Aid to Wildl. Rest. W-46-R. (HD)*

In this field research report, responses of juvenile and adult female white-tailed deer to harassment by dogs were studied from November 1977 through September 1978 in northcentral Tennessee. Although the habitat types of eastern temperate deciduous forest and agricultural fields are not comparable to those used by Sitka black-tailed deer in Alaska, the behavioral response of white-tailed deer and black-tailed deer to harassment in forested areas is expected to be similar. The activity of human disturbance was responsible for the documented direct impacts of active harassment, change in harvest level, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land was responsible for the documented direct impact of collision with a vehicle. Of 16 instances of recently translocated deer abandoning an area where they had been located for a week or more, 12 were due to chasing by dogs. In two instances, deer that definitely selected a home range abandoned it after dog and human harassment. Juvenile deer and does late in pregnancy were more reluctant to move long distances and chose new home ranges closer than did other female deer. The one deer that had fawned prior to five instances of dog harassment in three months did not abandon its home range. Mitigative guidelines are 1) to remove feral and free-roaming dogs from areas to which deer will be translocated and 2) to protect such deer from human harassment until they have become established. One deer was killed by a car, and one was shot illegally during a chase by dogs, during this study.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; parasitism and predation, increased susceptibility to.

Beasom, S.L., and C.J. Scifres. 1977. Population reactions of selected game species to aerial herbicide applications in south Texas. J. Range Manage. 30(2):138-142. (GD)#*

Data from this study indicate that it is possible to aerially spray with herbicides (in alternating strips) as much as 80% of mature honey mesquite brushland with no significant effects on white-tailed deer, nilgai antelope, wild turkeys, or feral hogs. Complete treatment (100% sprayed) apparently exceeded the threshold of suitability for all species except nilgai antelope. White-tailed deer densities were adversely correlated with production and species diversity of forb populations following aerial spraying.

Activity: chemical application.

Impact: vegetation damage/destruction due to air pollution or contact with petroleum products.

Behrend, D.F., and R.A. Lubeck. 1968. Summer flight behavior of white-tailed deer in two Adirondack forests. J. Wildl. Manage. 32(3):615-618. (GD)#

Comparisons of summer flight behavior of white-tailed deer on hunted and unhunted areas support the hypothesis that response to people is greatly modified by experience. The flight distance for antlered deer on the hunted area was significantly greater than for antlered deer on the unhunted area or antlerless deer on both areas.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Billings, R.F., and N.C. Wheeler. 1979. The influence of timber harvest on yield and protein content of Vaccinium browse on three dominant soil types. Pages 102-113 in O.C. Wallmo and J.W. Schoen, eds. Sitka black-tailed deer: proceeding of a conference in Juneau, Alaska. USDA, Forest Service, in cooperation with ADF&G. Series No. R10-48, May. (HD)*

In this field research paper, the effects of timber harvest in coastal forests of Southeast Alaska on the quantity and quality of winter forage for Sitka black-tailed deer produced at the edge of residual forest stands were determined. Two general types of climax forest ecosystems were sampled: those with closed canopies (55-85% closure) on well-drained soils and those with open canopies (35-65% closure) on somewhat poorly drained soils. Field research was conducted from September 1974 through February 1975. The activity of tree harvest resulted in documented indirect impacts of vegetation damage/destruction due to mechanical removal and vegetation composition change in the residual forest. Conclusive results were that a higher quantity of winter forage was produced in residual closed canopy forest stands, which decreased rapidly with distance from the edge (0.3 to 60 m, 1 to 164 ft) and that a higher quality (protein content) forage was produced under mature canopy conditions and in stands on poorly drained soils. According to calculations based on these data, rectangular clear-cuts up to 8 ha (20 ac) in size would increase browsable protein in stands on well-drained soil, if snow did not cover the enhanced browse along the edge, but any clear-cutting in stands on somewhat poorly drained soil would decrease total browsable protein. Pending further research on energy requirements of deer, snowpack burial of edge forage, and the relative importance of protein content, two management suggestions are made: 1) timber harvest should be conducted at elevations above key deer winter concentration areas; 2) if timber must be removed within 1.6 km (1 mi) of the beach line or below 150 m (492 ft) in elevation, irregularly shaped clear-cuts less than 8 ha (20 ac) in area should be made in closed canopy stands on well-drained soils only.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Bollinger, J.G., O.J. Rongstad, A. Soom, and R.G. Eckstein. 1973. Snowmobile noise effects on wildlife. Eng. Exp. Stn., Univ. of Wis., Madison 1972-1973 rept. 85 pp. Cited in R.L. Bury, Impact of snowmobiles on wildlife. 1978. Trans. N. Am. Wild. Nat. Resour. Conf. 43:149-156. (GD) #

This study found no increase in deer movements or change in activity patterns in response to snowmobiles. Deer seemed to react more to the sight than to the noise of snowmobiles. Deer were observed to remain close to men working with chain saws but moved away when a person tried to walk near them. Some disturbance was possible as snowmobiles initially moved into an area.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Campbell, E.G., and R.L. Johnson. 1983. Food habits of mountain goats, mule deer and cattle on Chopaka Mountain, Washington, 1977-1980. J. Range Manage. 36(4):488-491. (UAF)*

This first field research study on the food habits of mountain goats of all ages and both sexes was performed on Chopaka Mountain in the Cascade Mountain Range, northcentral Washington, during all four seasons from 1977 through 1980. Although this area is considerably south of Alaska, the habitats of the higher elevations, including alpine and subalpine graminoid and shrub stands and open subalpine fir and pine forests, are somewhat similar. Because cattle grazing has not yet occurred on goat habitat in Alaska, this information is the best that is available for use in Alaska. The activity of grazing cattle in the fall was responsible for documented indirect impacts of vegetation damage and destruction due to grazing by domestic cattle and competition with introduced domestic animals. Dietary overlap, predominantly of graminoids, was 32% between goats and cattle, 37% between mule deer and goats, and a minimal 15% between mule deer and cattle. Prior to the introduction of cattle, goats utilized the level top of the mountain as well as steeper terrain; now only steeper terrain is used by goats, implying competition for space as well as for forage.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Carbaugh, B., J.P. Vaughan, E.D. Bellis, and H.B. Graves. 1975. Distribution and activity of white-tailed deer along an interstate highway. J. Wildl. Manage. 39(3):570-581. (GD)#*

The distribution and activity of white-tailed deer (Odocoileus virginianus) were studied on a 12.9-km (8-mi) sector on Interstate Highway 80 in a forested region of central Pennsylvania from May 1968 to May 1969 and on a 12.4-km (7.75-mi) agricultural section of the highway from April 1968 to May 1969. Observations of deer were made from a vehicle equipped with a spotlight for nighttime observing. Over 6,500 deer were observed and categorized as to location, behavior, sex, and age. Numbers of deer seen were related to time of day, topography, vegetation, traffic, and meteorological factors. Most of the deer seen in the forested area were grazing on the highway rights-of-way; most of those seen in the agricultural area were grazing in fields and rarely were seen on the rights-of-way. Deer tended to move into our study areas at dawn. Neither traffic volume nor weather correlated strongly with numbers of deer seen; spring and fall were times of great deer abundance in both study areas, but vegetation type and topography were more important factors in the forested area than in the agricultural area. Feeding behavior of deer in both areas dominated all other activities. The impact of the highway itself on deer abundance and distribution and the relationship between deer activity and deer automobile collisions are functions of highway location relative to deer requisites, such as feeding and resting sites, and to the relative availability of feeding areas other than rights-of-way.

Activity: grading/plowing; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines.

Case, A.A., and D.A. Murphy. 1962. Poisoning in white-tailed deer. Pages 128-131 in L.E. Foote, chairman, Proceedings of the first national white-tailed deer disease symposium, February 13-15. Univ. Georgia, Athens, GA. 202 pp. (HD)

In this review article, reports of poisoning of white-tailed deer of all life stages were compiled throughout the geographic range of the species. Relevant observations were published in 1954 and 1957 and occurred at various times of the year. Although the geographic areas (Louisiana and Michigan) and habitat types (eastern deciduous and coniferous forests) are not comparable to those used by Sitka black-tailed deer in Alaska, the effects of chemical poisoning are expected to be similar in both deer species and to be independent of habitat type. The dusting of cotton plants with an arsenical compound for boll-weevil control resulted in the documented direct impact of poisoning when overbrowsing of natural vegetation forced deer to browse cotton plants. Improper application of an arsenical debarking compound poisoned deer in Michigan.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum, petroleum products, or other chemicals.

Caslick, J.W., and D.J. Decker. 1978. Control of wildlife damage in orchards and vineyards. Biological Sciences Natural Resources 10. Information Bull. 146. Ithica, N.Y. 18 pp. (ADF&G-F)*

In this information pamphlet, attraction of white-tailed deer of all life stages to orchards in New York State and means of preventing such attraction are discussed. White-tailed deer are related to Sitka black-tailed deer, and both are expected to respond similarly toward crops and deterrent techniques. Dates of the original studies on which the recommendations were based are not stated, but seasons of the year are mentioned. Studies were performed in all seasons of the year. Although the study area is at a more southerly latitude than Alaska and the habitat types of eastern deciduous and mixed forests, orchards, and farmlands are not comparable to those of Southeast Alaska, responses of deer to crops and to deterrent techniques are expected to be independent of these site differences. The activity of plowing (raising orchards and vineyards) was responsible for the documented direct impact of attraction to artificial food sources; the activity of chemical application was responsible for the documented indirect impact of vegetation damage (in terms of palatability to deer) due to contact with chemicals; and the activity of fencing was responsible for the documented direct impact of barriers to movement. Several methods are recommended to control deer damage. For high-value, high-density crops, a wire mesh fence at least 2.4 m (8 ft) high completely excludes deer and is cost-effective. Electric fences 1.2 to 1.8 m (4 to 6 ft) high with an outrigger wire 76 cm (30 in) above the ground and 0.6 to 1.2 m (2 to 4 ft) outside the main fence are much less expensive (one-tenth the cost) but require more maintenance, commonly fail where snow accumulates to 0.6 m (2 ft) or more, and will not effect control under high deer pressure. The chemical repellents Thiram (tetramethylthiuram disulfide) and ZIP (zinc dithiocarbamate - amine complex) can be effective when thoroughly applied to dormant terminal growth, if other foods are available to deer. Rainfall reduces the length of time the repellent is effective, and during the growing season the frequent respraying needed to protect new growth is costly and limits the usefulness of the repellent. Other control methods that have been practical and effective under limited conditions include dogs on wire runs; bags of odorants such as tankage, kerosine, creosote, or human hair; individual wire mesh enclosures for trees; and removal of deer.

Activity: chemical application; fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; vegetation damage/destruction due to air pollution or contact with petroleum products.

Dorrance, M.J., P.J. Savage, and D.E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39(3):563-569. (GD)#

Data suggest that deer, which had not been hunted for several years, became habituated to snowmobiles in an area receiving heavy weekend recreational snowmobile use. Light traffic displaced deer from areas immediately adjacent to trails. Increased traffic thereafter caused no further response. In an area where snowmobiles were generally prohibited, deer home range size, movements, and distance to nearest trails increased with snowmobile activity.

Activity: transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Eckstein, R.G., T.F. O'Brien, O.J. Rongstad, and J.G. Bollinger. 1979. Snowmobile effects on movements of white-tailed deer: a case study. Env. Conserv. 6(1):45-51. (HD)#*

The effects of snowmobile traffic on the winter home ranges, movements, habitat use and activity patterns of white tailed deer were studied during two winters in northern Wisconsin. There were no significant differences in home range size and habitat use of the deer in areas with and without snowmobiling. However, snowmobiling caused some deer to leave the immediate vicinity of the snowmobile trail. Deer were most affected when they were within 61 m (200 ft) of the snowmobile trail. Daily activity patterns were little affected by snowmobiles. Darkness reduced the reaction of deer to disturbance. One of the main factors in determining winter home ranges, activity patterns, and habitat use was the placement and timing of logging operations. Deer probably became accustomed to the noise of machinery and power saws, and this decreased their reaction to snowmobiles. This study confirmed other research reports that deer were more likely to move away from people hiking or skiing than from people riding snowmobiles.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Ellis, E.H., J.G. Goodwin, Jr., and J.R. Hunt. 1978. Wildlife and electric power transmission. Pages 81-104 in J.L. Fletcher, R.G. Busnel, eds. Effects of noise on wildlife. New York: Academic Press. (ARL)#

The potential effects of powerlines and rights-of-way are described. Construction and maintenance activities may cause displacement of wildlife. Wildlife avoidance of powerline corridors has been little studied. No published studies are known on the response of wildlife species to powerlines. Collisions with wires have been documented for many species of birds. These generally involve few birds but can be serious mortality factors in some cases. Legal and illegal hunting increase deer and elk mortality along rights-of-way and transmission line access roads, especially in previously unroaded areas. Raptors perched on utility poles are particularly vulnerable. Studies indicate that hunters concentrate along roads and cleared trails, and this has been shown to affect elk movement. Benefits of power lines include increased food for deer, elk, bighorn sheep, and black bear along corridors and additional perches and nest sites for raptors. Research in Idaho and Montana showed that a transmission line did not make a right-of-way less attractive to deer and elk feeding in the cleared area during early spring. No significant difference in big game use of rights-of-way and a control clearing was noted. Elk and deer showed no apparent hesitation in crossing the corridor.

Activity: grading/plowing; transport of personnel/equipment/material - land.

Impact: harvest, change in level.

Freddy, D.J., W.M. Bronaugh, and M.C. Fowler. 1986. Responses of mule deer to disturbance by persons afoot and snowmobiles. Wildl. Soc. Bull. 14(1):63-68. (UAF)*

This field research report describes a study conducted in northcentral Colorado on adult female mule deer from mid January until early March of 1979 and 1980. The habitat type of the cold desert winter range consisted of open sagebrush shrub vegetation on low ridges and south slopes. Mule deer are closely related to Sitka black-tailed deer and are expected to respond similarly to disturbance. Although the habitat type and latitude of the study area are not comparable to those of deer range in Alaska, the responses of deer in open vegetation in Alaska to the same activities are expected to be similar. The deer were hunted each fall, but while they were on their winter range they were disturbed only by this study. The activities of human disturbance (people snowshoeing) and transporting personnel by land (people riding snowmobiles on trails) were responsible for the documented direct impact of harassment, both active and passive. Snowmobiles were operated at a continuous speed of 16 to 24 km/hr (10 to 15 mph). Mean values for the distances at which deer responded to persons afoot and to snowmobiles by turning their heads toward the disturbance with ears upright were 334 m (1,096 ft) and 470 m (1,542 ft), respectively. The corresponding distances at which deer moved away from the disturbance were 191 m (626 ft) and 133 m (436 ft), respectively. Deer noticed snowmachines at a greater distance, but their avoidance response to humans on foot was made at a greater distance, for a longer time period, and more frequently involved running, resulting in a greater energy expenditure by the deer. Flight distances increased when a person afoot continued approaching a deer, indicating short-term sensitization. Mitigation recommendations are to remain at greater than the threshold distances to avoid disturbing deer on winter ranges.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Geist, V. 1971a. A behavioral approach to the management of wild ungulates. Pages 413-424 in E. Duffey and A.S. Watt, eds. The scientific management of plant and animal communities for conservation. Eleventh symp. Brit. Ecol. Soc., Blackwell Sci. Publ., Oxford, England. (ADF&G-F)*

In this review paper, the behavioral characteristics of wild ungulates including moose, Sitka black-tailed deer, mule deer (closely related to Sitka black-tailed deer), bighorn sheep (similar in behavior to Dall sheep), caribou, and reindeer (closely related to caribou), in various habitat types throughout the world, including arctic and subarctic areas, are discussed in relation to human disturbance. The original studies were made over the past three decades. The following activities are discussed: clearing, drilling, grading/plowing, human disturbance, and transporting personnel/equipment/-material by land and air. The results describing the direct impacts listed below are conclusive. Bighorn sheep are attracted to artificial food sources (stands of planted grasses) along highway embankments and ski runs and are killed by collisions with vehicles. Impassable barriers to movement of ungulates (species not specified) are created by snow ploughed off roads. Where several ungulate species coexist, significant changes in habitat preference by one species due to harassment may lead the "introduced" wild ungulate into competition with other wild ungulates, causing loss of other species. A change in harvest level (prolonged and extensive hunting) potentially will alter species biology to smaller, shorter-lived, more secretive forms of a species. Active and passive harassment has several detrimental effects, including increased susceptibility to predation and parasitism (lethal diseases in reindeer), mortality from emphysema (reindeer), running injury and calf trampling (reindeer), interference with weight gain and nutrition required for reproductive behavior (reindeer), and voluntary withdrawal from available habitat and confinement of the population to a smaller and maybe less favorable area. Returning to favorable habitat is most difficult and the effects of disturbance most severe for non-nomadic social species such as mountain sheep, and easiest for nongregarious ungulates (e.g., moose and deer) and nomadic social species (e.g., caribou). Recommendations are that habitat conservation alone will not assure success in maintaining populations of ungulates, particularly of social species. The fact that human contact results in learning (usually to the benefit of neither the ungulates nor man) must be employed constructively; steps may have to be taken to educate both visitors and ungulates in areas where visitors are common and to modify visitor behavior so as not to alienate the ungulates.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; introduced wild or domestic species, competition with or disease transmission from.

Greenwood, C.L., and L.B. Dalton. 1984. Mule deer passage beneath an overland coal conveyor. Great Basin Naturalist 44(3):499-504.

This field research report discusses the responses of mule deer of all life stages to an overland coal conveyor in Utah between April 10 and May 4, 1981. Habitat types consisted of pinyon pine - Utah juniper woodland, dry mountain shrub stands, and scattered stands of Douglas fir. Mule deer are closely related to Sitka black-tailed deer, and although the geographic area and habitat types of this study are not comparable to those of the coastal rain forests of Alaska, the responses of deer to a coal conveyor are expected to be similar. The activity of transporting material by land was responsible for the documented direct impacts of barriers to movement and passive harassment. Conclusive results were that no deer attempted to jump over the 1.8 m (6 ft) wide conveyor but that deer did pass beneath it, both when it was in operation and when it was idle. Deer avoided passing beneath the conveyor where the clearance between the conveyor and the ground was less than 50 cm (20 in) and never crossed where the clearance was less than 33 cm (13 in). Most deer crossed readily at clearances between 50 and 130 cm (20 and 51 in), and deer preferred clearances between 50 and 90 cm (20 and 35 in). Some deer showed signs of anxiety when near the conveyor, and a few refused to cross it at all, despite being highly motivated to do so. The following mitigation recommendations were made for consideration when planning an overland structure such as a conveyor or pipeline: 1) consider the known or projected response of big game already present in the area of the structure and of species that could potentially inhabit the area; 2) design crossing structures to allow for site-specific factors such as snow accumulation and vegetation growth and consider the use of drainages or cuts to facilitate designing crossings; 3) either study big game movements in the area and place passage structures where daily or migratory crossings occur, or elevate at least 60 to 70% of the structure adequately to facilitate crossing (at least 1 m [3.3 ft] for deer, with vertical supports at least 6 m [20 ft] apart); and 4) enhance the growth of vegetation that provides cover and forage along the barrier and at crossing locations. Recommendations for overpass structures are made but are not based on documented impacts to deer.

Activity: transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Hanley, T.A. 1984. Relationships between Sitka black-tailed deer and their habitat. Gen. Tech. Rept. PNW-168. Portland, OR. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station. 21 pp. (HD) *

In this review article, responses of Sitka black-tailed deer of all life stages to logging in southeast and coastal southcentral Alaska are discussed. Papers reviewed were written between 1945 and 1983, the majority after 1970, and cover research done at all seasons of the year. Habitat types include coastal spruce-hemlock forests and associated riparian areas, and alpine tundra. The activity of clearing and tree harvest is responsible for documented indirect impacts of barriers to movement, vegetation composition, change to less preferred or useable successional stage, and vegetation damage or destruction due to mechanical removal. Even-aged second-growth forests older than 20 years produce very little forage for black-tailed deer. Open stands, younger than 20 years, produce more forage than do old-growth stands, but heavier snow accumulation buries the forage so that it becomes unavailable. Logging slash and very dense shrub growth make movement in clear-cuts difficult even without snow cover, and forage quality is lower in clear-cuts, resulting in low deer use throughout the year. Moderate or high-volume commercial old-growth stands are critical winter range for deer, but other winter range in low-volume stands is necessary to prevent overbrowsing of critical range when snow is not deep. Management recommendations include the following: 1) retain patches of critical winter range that occur naturally within blocks of low-volume, noncommercial, or inoperable forest; 2) retain beach-fringe forest as temporary but critical refuge for deer during periods of deep snow accumulation; 3) clean up or burn logging slash; 4) clear-cut in many small, scattered, irregularly shaped areas rather than in few large block-shaped areas, except in areas prone to windthrow; and 5) spread cutting over the entire elevational gradient rather than beginning at lower elevations and moving upward.

Activity: clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Harestad, A.S., J.A. Rochelle, and F.L. Bunnell. 1982. Old-growth forests and black-tailed deer on Vancouver Island. Pages 343-362 in K. Sabol, ed. Transaction of the 47th North American wildlife and natural resources conference, Portland, OR, March 26-31. Wildlife Management Institute, Wash., D.C. 722 pp. (ADF&G-F)*

In this summary and review of field research, habitat use by Columbian black-tailed deer of all ages and both sexes in northcentral Vancouver Island, British Columbia, was examined throughout the year during an unstated time interval. Columbian black-tailed deer are very closely related to Sitka black-tailed deer. Habitat types included coastal hemlock forest, subalpine mountain hemlock forest, and the alpine zone. In years of heavy snowfall, the weather conditions and habitat types are very similar to those in areas utilized by Sitka black-tailed deer in Alaska. The activities of clearing and tree harvest were responsible for documented indirect impacts of vegetation composition change to less preferred or useable species or successional stage and vegetation damage or destruction due to mechanical removal. Winter habitat selection is discussed as a trade-off between energy availability (food) and energy expenditure (movement through snow). In periods of deep snowfall, most forage in clear-cuts is buried and unavailable to deer. Conclusive results show that arboreal lichens are a major winter food source in old-growth forests, and litterfall is also important and available under all snow conditions. During periods of deep snow, deer used old-growth forests during both night and day. Management recommendations are as follows: 1) reserve selected mature stands temporarily until second-growth stands attain a structure appropriate for both intercepting snow and permitting understory development; 2) use thinning and fertilization to manipulate second-growth stand structure. Arboreal lichens will not develop significantly under harvest cycles of 100 yr or less.

[Reviewer's note: Other studies (Schoen and Wallmo 1979, Taber and Hanley 1979) are less optimistic about the potential of modifying second-growth stand structure. Although the authors do not discuss the lack of the major food source, arboreal lichens, in second-growth forests, this would require substantially greater understory development than in old-growth forests as an alternate food source. Such understory growth would be difficult to achieve along with snow interception.]

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Harris, A.S., and W.A. Farr. 1979. Timber management and deer forage in Southeast Alaska. Pages 15-23 in O.C. Wallmo and J.W. Schoen, eds. Sitka black-tailed deer: proceedings of a conference in Juneau, AK. USDA, Forest Service, Alaska Region, Juneau. (HD)*

The interactions of forestry practices with winter habitat of Sitka black-tailed deer in coastal hemlock-spruce forests of Southeast Alaska are the subject of this brief review paper. Clearing and tree harvest is the activity responsible for the impacts of physical barriers to movement (direct), vegetation composition change (indirect), and vegetation damage or destruction due to mechanical removal (indirect). It is undesirable to manage highly variable, uneven-aged, defective, near-climax stands for timber production, although they provide essential winter shelter and forage for deer. Low productivity and high harvesting costs make selective cutting of such stands impractical. Clear-cutting is the optimum silvicultural system for regenerating old-growth stands. Large logging residues from defective trees (about 31% of gross board foot volume) can interfere with stand management and deer use for many years. Intensive management of regenerating stands includes repeated thinning, and the authors think that second-growth stands in some parts of Southeast Alaska can be thinned to produce accessible deer forage during parts of some winters without necessarily resulting in additional conifer regeneration and development of a two-storied conifer stand.

Activity: clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Hauge, T.M. 1985. Fencing guidelines. Letter to A.G. Ott, ADF&G, from animal damage specialist, Bureau of Wildlife Management, Dept. of Natural Resources, Wisconsin. 19 pp. (ADF&G-F)*

This field research letter and set of specifications describes fences that block the movements of white-tailed deer and moose of all life stages. White-tailed deer are related to Sitka black-tailed deer and are expected to respond similarly to fences. Although Wisconsin is at a more southerly latitude than Alaska, its continental climate results in habitat types somewhat similar to those in Interior Alaska: coniferous and deciduous forests with muskegs and bogs in poorly drained areas. The dates of the studies upon which the fencing recommendations were made are not stated. The activity of fencing was responsible for the documented direct impact of barriers to movement. The recommended seven-strand electric fence conclusively blocked 90 to 95% of deer that tried to cross it. A similar fence, taller by an unstated amount, successfully blocked moose. The recommended fence is a vertical high-tensile seven-wire electric fence with the top wire at least 1.5 m (60 in) above the ground and the bottom wire about 20 cm (8 in) off the ground. Smooth 12½ gauge wire is used. Each wire is charged and connected independently to the charger. To cross gates, the seven wires are insulated and buried in black PVC tubing. See the letter for other specifications for constructing the high-tensile electric fence.

Activity: fencing.

Impact: barriers to movement, physical and behavioral.

Hill, E.P. [1977?]. Prevention and control of deer browse damage in young stands of bottomland hardwood. Mississippi Coop. Fish and Wildlife Research Unit. 57 pp. (ADF&G-F)*

In this review article, the effects of attraction of white-tailed deer of all life stages to planted hardwood saplings in the eastern United States are discussed. Sitka black-tailed deer are related to white-tailed deer, and similar means of preventing or minimizing attraction to crop plants would be expected to apply. Although the study areas are at far more southerly latitudes than Alaska and the habitat types of eastern deciduous hardwood and mixed forest are comparable to the temperate wet coniferous forests of Southeast Alaska only in that they are both forested, deterrents to attraction are expected to be independent of habitat type. The papers cited were published between 1931 and 1977, most of them after 1950. The activity of fencing was responsible for the documented direct impact of barriers to movement, and of plowing (tree farming) was responsible for the documented direct impact of attraction to crops. The activity of chemical application was responsible for the documented indirect impact of vegetation damage (in terms of palatability to deer) due to chemicals. Conclusive results are that deer are attracted to hardwood (and coniferous) saplings, especially in recently planted stands under intensive management, including fertilization. Barbed wire livestock fences do not block movements of deer, but fences of woven wire mesh or outrigger fences of woven or barbless wire 2.4 m (7.9 ft) in height with the lower half sloping outward from the area to be protected to the ground excluded deer. All fences were too costly to use on regenerating forests. Maintenance problems and chargers of insufficient voltage made electric fences in general ineffective. Protective coverings of plastic or paper fibers blocked deer from individual saplings, but the labor of application was too expensive for general use. Some chemical repellents deterred browsing under certain circumstances without harming the saplings, but none protected new growth that had developed after the treatments. Scaring devices, including noisemakers, did not alter deer movements longer than the time needed for deer to become habituated, 1 or 2 weeks. The author recommends reducing the size of deer populations by either sex hunts 1 or 2 years before replanting forests where browsing is expected to damage the saplings.

Activity: chemical application; fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; vegetation damage/destruction due to air pollution or contact with petroleum products.

Holechek, J.L., R. Valdez, S.D. Schemnitz, R.D. Pieper, and C.A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildl. Soc. Bull. 10:204-210. (UAF)*

In this review article, specialized domestic livestock grazing systems that are less detrimental than continuous livestock grazing or are beneficial to mule deer and moose of all life stages on multiple use rangelands are discussed. The studies reviewed were performed between 1931 and 1981 in all seasons of the year and in a variety of geographic areas and habitat types, from cold, arid shrub-grasslands in the central Rocky Mountains through pastures and riparian shrub areas in Oregon and British Columbia. Mule deer are closely related to Sitka black-tailed deer. Although moose are not specifically mentioned, riparian shrub communities similar to those used by moose are discussed. The geographic areas and habitat types are not strictly comparable to those in Alaska, but the types of impacts and general mitigative methods are expected to be similar. The activity of grazing was responsible for the documented indirect impact of vegetation damage or destruction due to grazing by domestic animals and the direct impact of competition with introduced domestic species. Conclusive results showed that mule deer preferred areas under deferred-rotation cattle grazing to those grazed continuously by cattle, the preference increasing with the frequency of deferment. The quality of grass forage for elk and mule deer was improved by light-to-moderate spring or early summer cattle grazing to remove old leaves. On mule deer ranges where grasses and browse shrubs compete, limited grazing of understory grasses and shrubs by cattle or domestic sheep increased productivity of browse shrubs. Management recommendations include the following: 1) to avoid loss or allow recovery of woody deciduous plants (e.g., willows) in riparian areas, fence riparian areas separately, use limited rotation grazing at low stocking levels, or graze sheep controlled by herding instead of cattle; 2) recognize that burning and/or mowing in some cases improves habitat for wildlife better than does livestock grazing; and 3) a rotation grazing system that results in excessive defoliation of an area in order to rest another will be detrimental to habitat, wildlife, and livestock.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation damage/destruction due to grazing by domestic or introduced animals.

Hood, R.E., and J.M. Inglis. 1974. Behavioral responses of white-tailed deer to intensive ranching operations. J. Wildl. Manage. 38(3):488-498. (GD)#

This paper evaluates the effect of regular cattle roundups and the effect of the intermittent presence of large numbers of cattle on the movements and behavior of nine deer. The effects of deer disturbance were recorded by radio-tracking. Bucks usually reacted to a roundup with a long flight that took them into an adjacent pasture where disturbance was minimal. Does usually took a circuitous flight path that began and ended within their home range. The long-term effects of roundup disturbance suggested that does and bucks had different behavioral mechanisms for handling disturbance problems. Does seemed to have greater fidelity to their home ranges. Bucks, on the other hand, enlarged their home ranges or left them for varying periods of time. Circumstantial evidence indicated that some deer shifted their use areas in response to the presence of large numbers of cattle.

Activity: grazing; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from.

Jepson, R., R.G. Taylor, and D.W. McKenzie. 1983. Rangeland fencing systems state-of-the-art review. USDA:Forest Service Equipment Development Center. Project Record 8322 1201. 2200 Range. San Dimas, CA. Oct. 23 pp. (ADF&G-F)*

In this review paper, the effects of fencing on deer of all life stages are mentioned, and fences that will block deer movements or allow deer to pass through are described. Fences that block or direct coyotes of all life stages are also mentioned. Coyotes are found in Alaska, and Sitka black-tailed deer are sufficiently closely related to deer found in other areas of the Unites States that their behavior toward fences is expected to be similar. The studies cited were done in several areas at latitudes south of Alaska and in habitat types usually dissimilar to the temperate coastal wet coniferous forests of Southeast Alaska, but responses of deer and coyotes to fences are expected to be independent of habitat type. The dated studies and technical guides cited were published between 1962 and 1982, and many others were not dated. For deer, the activity of fencing was responsible for the documented direct impacts of barriers to movement and of entanglement. For coyotes, the activity of grazing of domestic sheep was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Recommendations for fencing designs are made. For coyotes, these are the same as those made in Gates 1978 and deLorenzo 1977, with additional data that the number of wires in the electric fence described in Gates 1978 has been decreased from 12 to 5 or 9 wires in areas such as Oregon, where coyote densities are low, with only a slight (5%) increase in coyote predation. Twelve wires are still recommended in areas of high coyote densities. Electroplastic netting also effectively excludes coyotes from domestic sheep, as well as contains sheep. Deer deterrent fences are essentially the same as the outrigger type described in USDA Forest Service 1978 and the 2.1 to 2.6 m (7 to 8½ ft) tall wire fences described in USDA/SCS 1979, USDA Forest Service 1978, and Rasmusson 1985. The outrigger type is easily damaged by livestock and will become useless as shrubs grow beneath it. In heavy snowpack areas, the tall net wire fence with posts 4.6 m (15 ft) apart requires high maintenance. The alternative design for such areas is a 2.4 m (8 ft) high 14-strand barbed wire fence with posts 3.7 m (12 ft) apart and with three-wire stays between posts. Three modifications are recommended for standard livestock fences to allow deer to pass more freely: limit fence height to 102 to 107 cm (40 to 42 in), use let-down fencing, and use smooth wire for the top two wires to avoid interlocking of barbs if a deer catches a hind leg, or place the top two wires 30 cm (12 in) apart. No single useful reference source on fencing considerations for wildlife was found by the authors.

Activity: fencing.

Impact: barriers to movement, physical and behavioral; entanglement in fishing nets, marine or terrestrial debris, or structures.

Jones, G. 1974. Influence of forest development on black-tailed deer winter range on Vancouver Island. Pages 139-148 in H.C. Black, ed. Proceedings of a conference on wildlife and forest management in the Pacific Northwest. Oregon State Univ., Corvallis. (HD)#

The response of deer in winter to various types of logged and unlogged habitats was studied on northern Vancouver Island. Habitat selection by deer was monitored during a severe and a mild winter. In both winters, deer use of unlogged, mature timber habitats was higher than use of logged habitats. In the severe winter, substantial deer use of mature timber was a result of shallow snow. In the mild winter, high deer use of certain habitat types in mature timber was probably a function of the density of the shrub cover. In the mild winter, deer use of logged habitats was low in January and increased linearly through April. Deep snow severely restricted deer use of logged habitats during the severe winter. It was concluded that under conditions of deep snow, deer require mature timber as shelter. In mild winters, deer prefer habitats with the best food supply, usually mature timber habitats with open crown cover.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Kinsey, C. 1976. Tests of two electric deer barrier forms. Minn. Wildl. Res. Quart. 36(3):122-138, and cover letter from P.D. Karns, Minnesota Department of Natural Resources, to A.G. Ott, ADF&G, 8 May 1985. (ADF&G-F)*

In this field research report, the responses of deer and moose of all life stages to single-wire electric fences were observed in late February and early March of 1975 and from October 1975 through March 1976 in farming areas of Minnesota. White-tailed deer are related to Sitka black-tailed deer and are expected to respond similarly to fences. Although the geographic area is at a more southerly latitude than Alaska and the habitat types of farmlands and northeastern mixed forest are not the same as those of Alaska, the behavior of deer and moose toward fences is expected to be independent of habitat type. The activity of plowing (farming) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. Two types of inexpensive electric fences were tested. Both were about 80% effective in repelling deer from attractive concentrated food sources, including corn cribs, alfalfa haystacks, and silage during the snowfree season, and also repelled an unstated percentage of moose. Snow insulated deer from the ground and rendered the fences ineffective. The recommended fence consists of a single wire at a height of 55 cm (22 in) on which aluminum foil flags 7.5 cm by 10 cm (3 in by 4 in) are attached at 90 cm (35 in) intervals by folding them around both the wire and a piece of adhesive cotton tape soaked in an attractant of anise, clove, and corn oils in glycerin. More effective attractants evaluated in a separate test were apple pulp, corn meal, soybean meal, and especially peanut butter, but extracts of these foods suitable for use on cloth tape were not prepared. The fence is most effective if deer can approach it calmly and inquisitively; if chased toward it, they jump over. If the fence is left uncharged, deer will lose respect for it. Research is in progress on a two-wire fence that is effective in snow.

Activity: fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Kirchhoff, M.D., J.W. Schoen, and O.C. Wallmo. 1982. Deer use in relation to forest clear-cut edges in Southeast Alaska. Appendix A, Pages 21-33 in J.W. Schoen, M.D. Kirchhoff, and T.A. Hanley, Seasonal distribution and habitat use by Sitka black-tailed deer in Southeastern Alaska and food habits of Sitka black-tailed deer in Southeastern Alaska. Vol. 3. ADF&G prog. rept, 1980-1981. Fed. Aid in Wildl. Rest. Proj. W-21-2, Jobs 2.6R. and 2.7R. Juneau. 51 pp. (ADF&G-F)

In this field research paper, the location of fecal pellets of Sitka black-tailed deer of all life stages with respect to the edges of forest clear-cuts on Chichagof and Admirality islands, Southeast Alaska, was studied in April 1980. Habitat types included uneven-aged old growth western hemlock-Sitka spruce coastal forest and clear-cut areas, which averaged 5.4 years in age in the same forest type. The activity of clearing and tree harvest resulted in the documented indirect impacts of vegetation damage or destruction due to mechanical removal. Conclusive results showed that during the winter, when food is limiting, deer utilized the old-growth forest more heavily than the clear-cut, and use was equally heavy or lighter within 30 m (98 ft) of the edge between forest and clear-cut than from 30 to 200 m (98-656 ft) from the edge into either the forest or clear-cut. Man-made edges offer no apparent advantages to deer in an old-growth environment that naturally provides high habitat diversity and excellent winter habitat conditions.

[Reviewer's note: The results of this study are in contradiction to Billings and Wheeler (1979), who provided evidence based on vegetation but not deer use that small clear-cuts in Southeast Alaska are not detrimental to deer.]

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

This review article discusses the interactions between agriculture and wildlife are discussed. The species include bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the contiguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine, during white settlement is attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain-growing areas in Alaska in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep, and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Krausman, P.R., B.D. Leopold, and D.L. Scarbrough. 1986. Desert mule deer response to aircraft. Wildl. Soc. Bull. 14(1):68-70. (UAF)*

This field research report describes a study conducted in southcentral Arizona on desert mule deer of all life stages except fawns from May through September of 1984. The habitat types of the summer range consisted of open dry coniferous forest interspersed with open shrub stands and meadows in mountainous terrain and adjacent warm desert flats dominated by creosote bush. Mule deer are closely related to Sitka black-tailed deer and are expected to respond similarly to disturbance. Although the habitat types and latitude of the study area are not comparable to those of deer range in Alaska, the responses of deer in Alaska to the same activity are expected to be similar. The activity of transporting personnel by air in light fixed-wing aircraft for the purpose of tracking radio-collared deer was responsible for the documented direct impact of active harassment. Deer had been habituated to passive harassment by low-flying aircraft following a nearby highway. The only response studied was whether or not deer moved to a different habitat type as a result of up to five overflights at 30 to 300 m (98 to 984 ft) agl for each relocation of a deer. Movement within a habitat type was not considered an impact. Three deer out of a total of 70 changed habitat types as a result of overflights at less than 150 m (492 ft) agl. Overflights at greater altitudes did not cause deer to change habitat types.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Kvale, C.T. 1980. Preliminary phosphate mining impacts on mule deer, elk, and moose in southeastern Idaho. Pages 527-546 in K.L. Colbo and R.W. Wiley, Proceedings of 60th annual conference of the Western Association of Fish and Wildlife Agencies and the Western Division American Fisheries Society, Kalispell, Montana, July 13-17. ix + 649 pp. (ADF&G-F)*

In this field research report, mule deer, elk, and moose of all ages and both sexes were studied since November 1976 as a part of an ongoing project involving both baseline data collection and impact mitigation. Mule deer are closely related to Sitka black-tailed deer and are expected to exhibit similar responses to disturbance. At elevations of 1,738-3,049 m (5,700-10,000 ft), areas of coniferous and aspen forest habitat are similar to Alaskan habitats, but mixed shrub-grasslands are also present in the study area. The activities of blasting, fencing, grading/plowing, human disturbance, processing of minerals, and transport of personnel/equipment/material by land were responsible for documented direct impacts of barriers to movement, entrapment, and passive harassment, and the indirect impact of vegetation damage/de- struction due to mechanical removal of material overlay. Migrating deer that moved through a mine site were conclusively delayed in reaching winter range by fences, roads, snow berms, and human disturbance. One deer was trapped in a fenced area. Subdivisions on hills that provide security points to migrating deer and loss of winter range to subdivisions and disturbance are affecting deer. Moose in the area are not migratory, and no impacts were mentioned. Recommendations are as follows: 1) use zoning and building permits to alleviate barriers to known deer migration routes and to decrease habitat loss; 2) purchase and enhance private land essential to wildlife for off-site mitigation. The study is still in progress, and results are considered preliminary.

Activity: blasting; fencing; grading/plowing; human disturbance; processing minerals (including gravel); transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Loft, E.R., J.W. Menke, and T.S. Burton. 1984. Seasonal movements and summer habitats of female black-tailed deer. J. Wildl. Manage. 48(4):1,317-1,325. (UAF)*

In this field research report, movements of adult female Columbian black-tailed deer were recorded on a daily to weekly basis from February 1981 through June 1982. Columbian black-tailed deer and Sitka black-tailed deer are closely related subspecies. Although the geographic location in the Trinity Alps of Northern California is considerably south of Alaska, deer undertake similar movements between winter range, which is usually at lower elevations, and higher-elevation summer range. As in Alaska, dense coniferous forests provide forage during winters with heavy snowfall. Habitat types are open and closed mixed coniferous forest, alder and willow riparian zones, oak and mixed chaparral, other mature shrub fields, montaine dry meadows, and clear-cuts. Not all habitat types are directly comparable to those in deer range in Alaska, but they satisfy similar seasonal habitat requirements. The activities of clearing and tree harvest, human disturbance, transport of personnel/equipment/material by land and by water, and water regulation were responsible for documented direct impacts of barriers to movement, entrapment in impoundments, passive harassment, and water level fluctuations, and the indirect impacts of terrain destruction and vegetation composition change. Conclusive results show that flooding of low-elevation winter habitat and migration routes after construction of two dams in 1963 resulted in loss of 4,000 or more deer from a herd of 20,000-25,000 due to starvation and drowning. Deer migrate by swimming 1 to 1.5 km (0.6-0.9 mi) across the lakes, but fawn mortality is high. Deer use clear-cut areas in summer, relying on stringers of uncut forest for cover and escape. In areas of active logging, deer have larger home ranges, tentatively because of human disturbance. Two deer used areas near a lake shore only at night, due to boat disturbance, and one deer remained more than 100 m (328 ft) from a highway during the day, moving closer at night. Mitigative guidelines are as follows: 1) manipulate habitat to create seral vegetation favored by pregnant does in spring transitional range areas; 2) protect riparian habitats from disturbances such as logging and mining during the fawning period; 3) retain dense, mature forest stands as winter foraging areas; 4) manage to increase habitat diversity, which results in smaller home range size and potentially higher deer densities.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/-material - water; water regulation/withdrawal/irrigation.

Impact: barriers to movement, physical and behavioral; entrapment in impoundments or excavations; harassment, active (hazing, chasing) or passive (noise, scent); vegetation composition, change to less preferred or useable species; water level or water quality fluctuations.

Longhurst, W.M., and J.R. Douglas. 1953. Parasite relationships of domestic sheep and Columbian black-tailed deer. Pages 168-188 in J.B. Trefethen, ed. Transactions of the 18th North American wildlife conference, Washington, D.C., March 9-11. Wildl. Mgt. Inst. 701 pp. (UAF)*

In this field research report, Columbian black-tailed deer of all life stages on ranges along the coast of northern California where domestic sheep are grazed were examined (along with the sheep) for parasites throughout the year from November 1951 through January 1953. Columbian black-tailed deer are very closely related to Sitka black-tailed deer. Although the habitat type of chaparral, oak forest, and woodlands with meadows is not comparable to deer habitat in Alaska, the impact discussed (transfer of worms), is dependent on a moist spring or summer climate and would be expected to be more likely in Alaska. The activity of grazing was responsible for the documented direct impact of disease transmission from domestic animals. Conclusive results showed that the twisted stomach-worm (Haemonchus contortus) was transferred rapidly in a pasture from infected sheep brought in from another area to previously uninfected deer during this study and could have serious effects on deer if present in sufficient numbers. Sheep brought in also transmitted nematode worms to deer. Unlike deer fawns, which either acquired nematode resistance their first fall or died and therefore carried relatively few worms over the summer, lambs carried a considerable worm burden through summer to reinfect the range for deer in the fall. Two of the three most serious parasites that contributed to heavy losses among deer were transmitted between sheep and deer. Management recommendations include 1) maintaining proper stocking rates for both deer and sheep and 2) using chemical control on sheep to reduce nematodes to avoid their transmission to deer.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

McAninch, J.B., M.R. Ellingwood, and R.B. Winchcombe. 1983. Deer damage control in New York agriculture. New York State Dept. of Agriculture and Markets. 15 pp. (ADF&G-F)*

In this field research report, the effects of chemical deer repellents and of fences on browsing of crop plants by white-tailed deer of all life stages in New York were studied during all seasons of the year over an unstated period of years. White-tailed deer are related to Sitka black-tailed deer, and are expected to react similarly to repellent and fences. Although the habitat types of eastern deciduous and mixed forests, orchards, and cultivated fields are not similar to the coastal moist temperate coniferous forests of Alaska, the differences not expected to affect the response of deer to repellent or fences. The activity of plowing (farming) was responsible for the documented direct impact of attraction to crops, the activity of fencing was responsible for the documented direct impact of barriers to movement, and the activity of chemical application was responsible for the documented indirect impact of vegetation damage (in terms of palatability to deer) due to chemicals. Repellent treatments are recommended for light-to-moderate deer damage or pressure, and fences for moderate-to-heavy damage or pressure when deer will consume even repellent treated woody crop plants. Spray repellents for the dormant season should be applied shortly after bud set and about every 6 to 8 wk thereafter. For the growing season, the first application should be made 2 wk after bud break, followed by reapplication every 3 or 4 wk and whenever browsing begins to occur. Also effective as repellents are light cloth or fine mesh bags filled with human hair or tankage and hung on attractive crops each spring and fall no farther than 0.9 m (3 ft) apart at a height of 71 to 81 cm (28 to 32 in). Four designs of high-tensile smooth wire electric fencing and one of woven-wire fencing are recommended based on crop acreage and deer pressure. For low deer pressure on small acreages, a double fence spaced 0.9 m (36 in) apart with two wires at heights of 38 and 91 cm (15 and 36 in) on the outer (deer side) fence and one wire at 69 cm (27 in) on the inner fence is recommended. For low-to-moderate deer pressure on small acreages, the outer fence is the same, but the inner one (that also deters small mammals) has five wires at 13, 25, 43, 69, and 97 cm (5, 10, 17, 27, and 38 in). For low-to-moderate deer pressure on small-to-moderate acreages, a vertical fence is preferable, from 1.2 to 2.1 m (4 to 7 ft) high, with the lower wire no more than 25 cm (10 in) from the ground, preferably at 20 cm (8 in), and the remaining wires spaced at 20 to 25 cm (8 to 10 in) intervals to the desired height. For moderate-to-high deer pressure on moderate-to-large acreages, a slanted seven-wire fence 1.2 m (4 ft) high on the deer side with 2.1 m (7 ft) long rails extending to the ground, with the lowest wire 25 cm (10 in) from the end of the rails and wires spaced every 30 cm (12 in) along the rails, is recommended. For high deer pressure on very large acreages, a vertical fence of 15 by 30 cm (6 by 12 in) wire mesh 2.4 m (8 ft) high, topped by additional strands of barbed or smooth wire at 23 cm (9 in) intervals to extend the height to 2.7 or 3.0 m (9 or 10 ft) if necessary, is recommended. Detailed directions for planning, construction, and maintenance of these fences are included.

[Reviewer's note: This paper describes application techniques and conditions under which repellents are useful, whereas Wingard and Palmer 1982 do not recommend the use of repellents under any circumstances.]

Activity: chemical application; fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; vegetation damage/destruction due to air pollution or contact with petroleum products.

Merriam, H.R. 1971. Deer report. Proj. prog. rept., Fed. Aid in Wildl. Rest. Projs. W-17-2 & W-17-3, Job 2.2R. ADF&G, Juneau. (GD)#

The author evaluated the effects of the herbicide 2,4-D on deer food species. The herbicide 2,4-D was used at a rate of 2.3 kg/ha (2 lb/ac) to control red alder in order to improve conifer regeneration rates. The most significant effect was the total killing of Vaccinium ovalifolium (blueberry), which was the most important winter browse species used by deer. There was little noticeable effect on other deer food species. Most ground forbs were not noticeably effected by the herbicide.

Activity: chemical application.

Impact: vegetation damage/destruction due to air pollution or contact with petroleum products.

Michael, E.D. 1978. Effects of highway construction on game animals. Proc. Ann. Conf. Southeast. Assoc. Fish. and Wildl. Agencies 32:48-52. (UAF)#

Populations of white-tailed deer, rabbit, ruffed grouse, gray squirrel, and turkey were apparently not affected by road construction (using heavy equipment and blasting). The amount of animal sign near the highway did not differ significantly from the amount 1.6 km (1 mi) away for any species. For these species, habitat loss is restricted to the area occupied by pavement, berm, and right-of-way. The addition of right-of-way vegetation and creation of ecotonal areas will cause some wildlife species to increase, while others decrease.

Activity: clearing and tree harvest; grading/plowing.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Millar, N. 1983. [Letter to Alaska Department of Fish and Game describing results of questionnaire, February 1983.] (HD)#*

This questionnaire dealt with the impact that different road standards have on wildlife.

Impacts on wildlife movement and habitat were believed to increase with higher road classes:

1) Class 1 roads (4-lane paved) were considered very restrictive to movement and very high in losses of habitat use. However, densities of class 1 roads were less than 0.1 km per square km (0.16 mi/mi^2) of area.
2) Class 2 (2-lane paved) and class 3 (2-lane gravel) roads were thought to restrict some movement and to reduce some habitat use. The densities of class 2 and 3 roads were 1.0 km per square km (1.6 mi/mi^2) of each area or less.
3) Class 4 (1-lane gravel or dirt) and class 5 (primitive track) roads were thought to have little influence on movement and little loss in habitat use. The densities of these roads were 2.6 km per square km (4.2 mi/mi^2) or less.

The greatest number of kills per km (mi) were reported on class 1 or 2 roads. There were no reported kills on class 5 roads.

Trends show design speed of greater than 64 kph (40 mph) and surface width of greater than 10 m (33 ft) contributed to mule deer mortality in forestry areas.

Wide clearing widths (exact width not stated) were thought to contribute to mule deer, white-tailed deer, sheep, and elk mortality.

Activity: clearing and tree harvest; grading/plowing; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Moen, A.N., S. Whitemore, and B. Buxton. 1982. Effects of disturbance by snowmobiles on heart rate of captive white-tailed deer. N.Y. Fish & Game Journal 29(2):176-183. (GD)#*

Captive deer exhibited increased heart rates in response to controlled tests of the effect of disturbance by snowmobiles conducted from December to March. Peak rates averaged 2.5 times prestimulus rates when the snowmobile moved tangentially to the deer and 2.9 times when it circled the deer. There was no evidence of habituation, either in magnitude of the response or in the time required for the heart rate to return to a prestimulus level. Snowmobile disturbances in wintering areas have the potential to increase energy expenditures of the deer, contrary to the long-term energy conservation adaptations.

Activity: transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Parker, K.L., C.T. Robbins, and T.A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. J. Wildl. Manage. 48(2):474-488. (UAF)*

This field research report is a study of mule deer and elk less than 18 months of age during an unstated time period in the states of Washington and Wyoming. The animals were bottle-raised and kept in pens; experiments were performed on roads or on uniform natural substrates, so habitat types are not important. Metabolic gas exchange studies such as this could not be done under less controlled conditions. The results are discussed in the context of the activities of human disturbance, clearing, and tree harvest, which result in documented direct impacts of barriers to movement and active and passive harassment. Conclusive results are presented for metabolic costs of movement across bare ground and through snow and are calculated for movement through snow-free logging slash. Movement through snow greater than front knee deep or through crusted snow entails dramatically increased energy output (e.g., an increase of five times the snow-free cost). Only by decreasing their velocity do free-ranging ungulates maintain acceptable energy expenditures. Similar results pertain to logging slash deep enough to require the animal to jump. Energy costs per harassment event are calculated, as are those of movement through snow-covered clear-cuts or slash versus forests. Management recommendations include the following: 1) consider restricting human access to ungulate winter use areas if maximum survival of ungulate herds is a primary concern; and 2) conduct more detailed studies of the use of clear-cuts, given that the high energy costs of movement through slash and/or deep snow would favor clear-cut avoidance.

Activity: clearing and tree harvest; human disturbance.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Porter, W.F. [1982]. A modified electric live-stock fence for controlling deer depredation in orchards. State Univ. New York, Coll. of Environ. Sci. and Forestry, Syracuse, N.Y. 1 pp. (ADF&G-F)*

In this field research report, the use of an electric fence to decrease browsing of white-tailed deer of all life stages on young orchard stock was tested in central New York during the growing seasons of 1979, 1980, and 1981. Deer populations were below carrying capacity. White-tailed deer are related to Sitka black-tailed deer, and although the habitat types of eastern deciduous and mixed forests and agricultural areas are not comparable to the temperate coniferous rain forests of coastal Southeast Alaska, the responses of deer to crops and fences are expected to be similar. The activity of plowing (growing orchards) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing for the documented direct impact of barriers to movement. An electric fence consisting of a single wire at an unstated height, with aluminum foil flags baited with peanut butter hung on the wire, decreased browsing from 37% to 80% of branch tips on control plots to 1 to 3% on fenced plots. The fence is inexpensive and easy to construct compared to other electric or uncharged wire deer fences.

Activity: fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral.

Preston, D.J. 1983b. The impacts of agriculture on wildlife. ADF&G, Fed. Aid in Wildl. Rest. Final rept. (Research) Projs. W-21-2 and W-22-1, Job 18.6R. Juneau. 143 pp. (ADF&G-F)*

In this review paper, the effects of agriculture on all life stages of a variety of wildlife species throughout North America are discussed. The following wildlife species and species groups featured in the Alaska Habitat Management Guide are included: swans, geese, ducks, several furbearers, brown bears, deer, moose, caribou, mountain goats, and Dall sheep. These species either occur in Alaska or are closely related to Alaskan species and are expected to respond similarly to agricultural activities. The 1,200 references cited range throughout the geographic areas and habitat types of North America. In most cases, the overall impacts of agriculture are independent of the specific location in which they were documented. The original studies were done throughout all seasons over the past several decades and were published primarily after 1970. Most of the impacts are discussed in terms of major wildlife species groups (e.g., birds, ungulates) and are not applicable to the species approach used in the AHMG. The few impacts identified as affecting moose, mountain sheep, and furbearers are summarized by species, followed by mitigation guidelines suggested for those impacts.

Moose. The activities of clearing and tree harvest and grading and plowing were responsible for the documented indirect impact of vegetation composition change, and the activity of grading and plowing was responsible for the documented direct impact of attraction to an artificial food source. Conclusive results were that 1,200-2,000 ha (3,000-4,000 ac) of good moose winter range were lost to the Delta agricultural project. Cultivated land is used less than other habitat types. Moose are attracted to gardens, especially in rural areas of Alaska. Mitigation recommendations are to protect crops by means of fencing designed to minimize entanglement of moose and by other nonlethal methods.

Sheep. The activity of grazing has been responsible for the documented direct impact of competition with or disease transmission from domestic species. Impacts were documented on bighorn sheep only, but effects on Dall sheep are expected to be similar. Livestock compete with bighorns for forage, and domestic sheep have transmitted three lethal diseases to bighorns: scabies mites, bluetongue virus (sampled for and found not to be present in Alaskan wildlife), and parainfluenza-3 virus (which causes pneumonia). The mitigation recommendation is to prohibit grazing livestock in or near (no distance stated) Dall sheep range.

Furbearers. The activities of grading and plowing and grazing were responsible for the documented direct impact of attraction to artificial food sources. The activity of fencing was responsible for the documented direct impact of barriers to movement and that of chemical application for the documented direct impact of mortality due to ingestion of chemicals. Squirrels are attracted to gardens, coyotes to domestic sheep, calves, and poultry, and wolves to sheep, calves and yearlings, and horses. Coyotes are

poisoned by chemical traps and by toxic collars on domestic sheep and are kept out of flocks of domestic sheep by deterrent, directing, or electric fences. Mitigation recommendations include restricting calving and lambing to easily monitored areas and disposing of livestock carcasses properly.

Deer. The activity of grading/plowing (growing crops) was responsible for the documented direct impact of attraction to an artificial food source, and the activity of fencing was responsible for the documented direct impact of barriers to movement. The activity of grazing was responsible for the documented direct impact of disease transmission from introduced domestic species. These impacts were documented on white-tailed and black-tailed deer, and effects on Sitka black-tailed deer are expected to be similar. Five strand high-tensile electric fencing successfully prevented deer that had been attracted to crops from entering fields or orchards and was not prohibitively expensive. Lethal epizootics of foot and mouth disease, bluetongue, and epizootic hemorrhagic disease have spread through deer populations in the contiguous 48 states after livestock transmitted the diseases to deer. Deer in Florida have also been infested by the cattle fever tick. In two documented cases, tens of thousands of deer were slaughtered to prevent reinfection of livestock. Recommendations are to actively implement existing disease regulations pertaining to importing livestock into Alaska and to monitor wildlife populations for exposure to livestock pathogens. Regulations require that imported livestock be free from disease.

Mountain goat. No impacts on mountain goats were documented in this paper.

An extensive subject index, including a taxonomic index to wildlife species, directs the reader to the references cited. Numerous other mitigation recommendations are made but are not directly supported by impacts documented on a stated wildlife species.

[Reviewer's note: This is an excellent, thorough review of the agricultural impact literature within and outside of Alaska. Not all references are applicable to Alaska, and impacts are not all documented in the sense used in the AHMG.]

Activity: fencing; grading/plowing; grazing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; introduced wild or domestic species, competition with or disease transmission from.

Reed, D.F., T.N. Woodard, and T.M. Pojar. 1975. Behavioral responses of mule deer to a highway underpass. J. Wildl. Manage. 39(2):361-367. (GD) #

A concrete box underpass 3.05 x 3.05 m (10 ft) and 30.48 m (100 ft) long under Interstate 70 in west central Colorado was monitored for deer use during four years following its completion in early 1970. A seasonal mean of 345.1 ± 133.0 (SD) mule deer (Odocoileus hemionus) passed through the structure when moving to or from their summer range. A video time-lapse surveillance system recorded behavioral responses during four migration periods, spring-summer and fall in 1972 and 1973. On the basis of video playback of 4,450 approaches and 1,739 entrances, deer displayed three basic overt responses: look-up, tail-up, and muzzle-to-ground. The frequency of the look-up response was indicative of the reluctance of the animals to go through a structure of this size and character. The underpass was successful in permitting about 61% of the total local deer population to migrate safely under the highway.

Activity: transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral.

Regelin, W.L. 1979. Nutritional interactions of black-tailed deer with their habitat in Southeast Alaska. Pages 60-68 in O.C. Wallmo and J.W. Schoen, eds. Sitka black-tailed deer: proceedings of a conference in Juneau, AK. USDA, Forest Service, Alaska Region, Juneau. (HD)*

Browse availability and nutritional requirements of Sitka black-tailed deer in Southeast Alaska are discussed in this review article, including effects of logging. Both winter and summer range conditions are covered, the corresponding habitat types being spruce-hemlock forest and alpine tundra. Clearing and tree harvest is the activity responsible for the impacts. Documented impacts include barriers to movement (direct), vegetation composition change (indirect), and vegetation damage or destruction due to mechanical removal (indirect). Following clear-cutting of climax spruce-hemlock forests, snow depth patterns and forest succession affect deer habitat. Snow depth is from two to as much as five times greater in clear-cuts, conclusively limiting deer use. Tentatively, 20 to 60 yr after logging, browse species are shaded out of regenerating stands, not to develop again until about 200 yr after clear-cutting. The existence of climax spruce-hemlock forest may be the one ameliorating factor allowing deer to survive in Alaska by minimizing the winter energy-deficit period. It appears that the loss of climax forest due to any cause results in a decrease in the potential of that area to support deer. The only mitigation consists of multiple use forest management practices that preserve adequate amounts of old-growth forest for deer.

Activity: clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Richens, V.B., and G.R. Lavigne. 1978. Response of white-tailed deer to snowmobiles and snowmobile trails in Maine. Can. Field-Nat. 92(4):334-344. (ARL)#

White-tailed deer response to snowmobiles seemed dependent on the deer's apparent security. Animals in the open or in hardwood stands tended to run when approached by snowmobile. Deer in softwood stands, which provided more cover, showed a greater tendency to stay when approached. A significantly greater number of deer ran from a man walking than from a man on a snowmobile.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Rost, G.R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. J. Wildl. Manage. 43(3):634-641. (GD)#*

Data from fecal pellet counts indicate that deer and elk avoid roads, especially areas within 200 m (656 ft). Road avoidance was greater 1) east than west of the continental divide, 2) along more heavily travelled roads (trends only), 3) by deer compared to elk, 4) for deer in shrub habitat compared to pine and juniper, and 5) in the species' primary winter habitat. The greater avoidance on the east side may reflect a greater availability of habitat away from roads due to lower snow accumulation. Data suggest that ungulates "may utilize areas near roads when hunger is sufficient to overcome fear." However, "deer west of the divide avoided roads, at least on some sites, even though snow accumulation presumably restricted their available habitat." Factors affecting the reactions of ungulates to roads and road- associated disturbance may be very complex and include the species involved, the age and type of road, traffic density, road-associated construction, distance from road, vegetation type, season, whether the population is hunted, and whether the road is located in an abundant or scarce habitat type. The effect of roads on individual welfare and herd productivity is not clear.

Activity: transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Schoen, J.W., and M.D. Kirchhoff. 1983. Seasonal distribution and habitat use by Sitka black-tailed deer in Southeastern Alaska. Vol. 4. ADF&G, Fed. Aid in Wildl. Rest. Prog. rept., 1981-1982. Proj. W-22-1, Job 2.6R. Juneau. 50 pp. (ADF&G-F)

In this field research report, Sitka black-tailed deer of all life stages were studied at several times of the year between July 1981 and June 1982 on Admirality Island, Southeast Alaska. Habitat types included old-growth uneven-aged spruce-hemlock forests, second-growth forests, subalpine shrub stands, alpine tundra, and riparian areas. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. Radio telemetry studies showed conclusively that during winter (January through March), deer prefer and almost exclusively (98% of relocations) utilize old-growth forest habitat, rather than second-growth forests.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Schoen, J.W., and O.C. Wallmo. 1979. Timber management and deer in Southeast Alaska: current problems and research direction. Pages 69-85 in O.C. Wallmo and J.W. Schoen, eds. Sitka black-tailed deer: proceedings of a conference in Juneau, AK. USDA, Forest Service, Alaska Region, Juneau. (HD)*

In this preliminary research report, the effects of timber harvest on Sitka black-tailed deer winter habitat in Southeast Alaska are discussed. The initial field work was conducted in the fall of 1977 and winter of 1977-1978 in coastal spruce-hemlock stands on Admiralty and Chicagof islands. The activity of clearing and tree harvest was responsible for the documented impacts of physical barriers to movement (direct), vegetation composition change to less useable species, and vegetation damage or destruction due to mechanical removal (indirect). Tentative results based on initial data show that even summer deer use of clear-cuts decreases to one-sixth that in the old growth in the early years after clear-cutting. From 15 to 30 or 40 yr after clear-cutting, regrowth plus slash is too dense for normal use by deer. Deer use remained low in a 147-yr-old regrowth stand. In winter, abundant deer sign was observed in a selectively cut uneven-aged forest but not in an adjacent clear-cut, and snow was much deeper in the latter. Forage quality measurements showed evergreen forage to be of much higher quality than deciduous forage in winter. Such forage is far more abundant in old-growth forests than in regenerating stands even older than the 100-yr planned rotation period and more available in old growth. This management policy for rotation would impair deer habitat on managed sites forever. Under current timber management practices, optimum winter deer habitat in the Tongass National Forest would decline to almost none in 200 yr. The authors caution that these are preliminary and partial results of incomplete studies.

Activity: clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Schoen, J.W., M.D. Kirchhoff, and O.C. Wallmo. 1982. Sitka black-tailed deer - old-growth forest relationships in Southeast Alaska: implications for management. In Proceedings of a symposium on fish and wildlife relationships in old-growth forests. Perspectives 1:(in press) (ADF&G-J)#

Population levels of Sitka black-tailed deer (Odocoileus hemionus sitkensis) are expected to decline as timber harvest of old-growth forests in Southeast Alaska proceeds. The extent of this decline will vary in accordance with the quantity and quality of old-growth acres harvested. Old growth in Southeast Alaska is likened to a fine-grained mosaic of habitat patches that deer utilize selectively - seasonally and annually. Impacts of harvesting of certain timber stands on long-range deer-carrying capacity and on other wildlife in Southeast Alaska will be difficult to assess until wildlife old-growth habitat relationships are better understood. This paper reviews deer-forest relationships in Southeast Alaska and outlines current forest management practices. Two approaches for allocation of old growth as deer habitat are compared: 1) allocation-by-stand and 2) allocation-by-watershed. We conclude that allocation-by-watershed is the more appropriate management approach in Southeast Alaska.

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Schoen, J.W., M.D. Kirchhoff, and O.C. Wallmo. 1983. Sitka black-tailed deer - old-growth forest relationships in Southeast Alaska: implications for management. Appendix B, pages 31-50 in J.W. Schoen, and M.D. Kirchhoff, Seasonal distribution and habitat use by Sitka black-tailed deer in Southeastern Alaska. Vol. 4. ADF&G, Fed. Aid in Wildl. Rest. Prog. rept., 1981-1982. Proj. W-22-1, Job 2.6R. Juneau. March. 50 pp. (ADF&G-F)*

In this review and discussion paper, the effects of tree harvest on Sitka black-tailed deer of all life stages in Southeast Alaska are discussed. The papers cited in this review were written primarily between 1977 and 1983 and cover research done during all seasons of the year in Southeast Alaska and comparable areas. Habitat types include old-growth uneven-aged Sitka spruce-western-hemlock forests, second-growth forests, subalpine alder shrub stands, alpine tundra, and riparian areas. The activity of clearing and tree harvest is responsible for the documented indirect impacts of vegetation composition change to less useable species or successional stage and vegetation damage or destruction due to mechanical removal. Conclusive results of the papers cited show that in winter deer rely on old-growth forests rather than earlier stages of forest succession to obtain sufficient energy from forage to survive. Recent (less than 20 years old) clear-cuts provide summer forage, but even-age regrowth stands (from 20-30 years to the 90-125-year harvest rotation period) contribute little toward deer carrying capacity at any time of the year. There is little reason to expect that silviculture techniques such as thinning, as currently practiced, will significantly improve this situation. High-volume old-growth stands that are the most important deer winter range during heavy snow years are being harvested preferentially, maximizing impacts on deer. Reservation of only these stands, however, would result in overuse due to lack of alternate habitat in shallow snow years and has resulted in the direct, tentatively documented impact of increased susceptibility to predation by wolves on deer concentrations. It would also result in habitat islands of little use to deer. The management recommendation is to select entire watersheds for retention while managing other watersheds for timber harvest, rather than harvesting portions of every watershed.

Activity: clearing and tree harvest.

Impact: parasitism and predation, increased susceptibility to; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sigman, M.J., ed. 1985. Impacts of clearcut logging on the fish and wildlife resources of Southeast Alaska. ADF&G, Div. Habitat, Tech. Rept. 85-3. 95 pp. Juneau. (ADF&G-F)*

This review article discusses the effects of clear-cut logging on Sitka black-tailed deer, mountain goat, moose, brown and black bear, Bald Eagle, marten, mink, land otter, and red squirrel of all life stages, among other species. Most of the papers cited describe research done in Southeast Alaska since 1970, but older publications and studies performed on the same species in other geographic areas where the habitat types and latitude are similar to those of Southeast Alaska are also included. The studies were done at all seasons of the year. The habitat type is coastal temperate rain forest dominated by Sitka spruce, western hemlock, and other conifers. In addition to documented impacts, potential impacts are discussed, and life history and habitat use information is presented for each wildlife species. Only documented impacts and recommendations made in the cited papers are summarized below by species. Management recommendations made by the author are generalizations of those made in the cited papers and are not repeated here.

Sitka black-tailed deer. The activity of clearing and tree harvest was responsible for the documented direct impact of barriers to movement and for the documented indirect impacts of vegetation composition change to less preferred successional stage and vegetation damage or destruction due to mechanical removal. Dense shrubs and slash in clear-cuts less than 15 to 40 years old precludes deer movement and use in summer, and in winter higher snow depths in clear-cuts nearly prevent deer use and movement. Even in winters of little snow accumulation and in summer, deer avoid clear-cuts and prefer mature old-growth forest habitats. Precommercial thinning may prolong understory production in stands prior to canopy closure, but any effect is short-lived and a two-layered conifer stand results. Deer populations have declined by 50 to 75% after clear-cutting of areas on and near Vancouver Island, B.C. Mitigation recommendations are to burn slash or clear trails through it for deer, to cease disproportionate harvest of high-volume old-growth timber, and to avoid harvesting old-growth stands with exceptional fish and wildlife values.

Mountain goat. The activities of clearing and tree harvest and human disturbance were responsible for the documented direct impact of harassment. The activities of grading/plowing (road construction) and transporting personnel/equipment/material by land were responsible for the documented direct impacts of barriers to movement, harassment, and change in harvest level. Logging, logging camps and associated human noise, and vehicle traffic disturb goat behavior and cause abandonment of preferred high-quality summer range within and near the disturbances. The effects from logging camps have been documented within a 2 km (1.25 mi) radius and include increased mortality of goats. Construction of new roads has blocked goat movement and led to overharvest of previously less accessable populations. No recommendations based on documented impacts were made.

Moose. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. Although the high amount of forage in recent clear-cuts is beneficial to moose in areas of Southeast Alaska where riparian foreage is not abundant, as clear-cuts become dominated by young conifers moose cease using them. During periods of deep snow, moose do not use even recent clear-cuts but feed in high-volume old-growth and river terrace forests and in riparian shrub stands. Mitigation recommendations are to retain forests around and within high-density feeding, breeding, and movement areas, and to retain any old growth river terrace forests or any other old-growth forest types that are limited in extent in the area of concern, as well as a portion of old-growth forests even if they are not limited in extent.

Furbearers. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. No impacts on wolves were documented, only on an important prey species included in the AHMG, Sitka black-tailed deer (q.v.). Populations of marten decline when mature coniferous forests are clear-cut, due to greatly decreased populations of red-backed voles, an important prey species, and due to loss of den sites in hollow trees and deadfalls. In winter, marten do not hunt in clear-cuts but only in dense, mature coniferous forest stands. They will cross but will not hunt in openings greater than 91 m (300 ft) in width. No mitigation recommendations were made for marten. Mink made almost no use of clear-cuts. Mitigation recommendations are to retain windfirm shoreline buffer strips at least 60 m (197 ft) inland from the shoreline. If shoreline forests must be clear-cut, keep the length of shoreline cut as short as possible, never more than 0.8 km (0.5 mi), and avoid cutting shoreline timber on points and in other areas where narrow timber stands separate shorelines, along intertidal zones where the distance between the 0 and +6 m (+20 ft) lines are less than 40 m (131 ft) apart, and along intertidal areas with high exposure of bedrock and boulder cover. Land otters avoid using clear-cuts for travel, burrows, or natal dens. Mitigation recommendations are to avoid logging adjacent to watercourses from early May to late summer (the breeding season) and to retain a windfirm fringe of forest 50 to 75 m (164 to 246 ft) wide along the beach to meet otter habitat requirements. Denning and feeding areas for red squirrels are eliminated by clear-cutting. Red squirrels cannot utilize clear-cuts until cone production by revegetating conifers is reestablished after 20 to 40 yr.

Brown bear. References reviewed for impacts to brown bear included studies conducted in coastal forests and studies conducted in interior forests (e.g., Montana). The activity of clearing and tree harvest produced documented impacts of changes in vegetation composition to less preferred successional stages (e.g., changing old growth to even aged forest), vegetation damage and destruction due to mechanical removal, barriers to movements (e.g., extensive areas of slash), and harassment. The activity of grading (road building) produced a documented direct impact of harassment.

The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source (i.e., garbage). The activity of human disturbance produced documented direct impacts of harassment and an increase in the harvest of bears (nuisance kills and increased access for hunters).

Bald Eagle. The activity of clearing and tree harvest produced a documented indirect impact of vegetation damage/destruction due to mechanical removal. Logging within 45 m (150 ft) of nest trees resulted in blowdown of nest trees at a rate 20 times more common than when logging occurred further than 45 m (150 ft) from the nest trees.

Activity: clearing and tree harvest.

Impact: barriers to movement, physical and behavioral; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Simpson, P.W., J.R. Newman, M.A. Mather, and P.A. Guthrie. 1982. Manual of stream channelization impacts on fish and wildlife. FWS/OBS-82/24. 155 pp. (HD)#

This manual contains a synthesis of the diverse literature dealing with the effects of stream channelization, allowing the reader to develop an understanding of channelization impacts on fish and wildlife resources associated with such streams. Major topics include: 1) regulatory history of stream channelization, 2) structural, physical, and chemical impacts of channelization, and 3) biological impacts of channelization. Information is summarized to provide the user with an overview and general understanding as well as analysis of key studies of the impacts of channelization.

The effects of channelization include: 1) loss of woody vegetation, 2) changes in bank composition and configuration, 3) low water levels, 4) reduction of channel snags and debris, and 5) reduction or loss of aquatic organisms. Alteration of the bank shortens the available bank for burrows or dens and reduces the foraging area for beaver. Construction of berms to replace the natural bank reduced denning opportunities due to deposition of sand and gravel on the berm. Loss of vegetation along the channel reduced available cover and food sources for beaver.

Large mammals such as deer are very mobile with large ranges and therefore, are less likely to be affected by impacts of channelization. Several researchers found deer using channelized sites and could find no significant differences between channelized and unchannelized sites.

Channelization may reduce the value of riparian systems as travel lanes for deer, especially in agriculture or non-wooded areas. The corridor effect of channelization influences human accessibility and hunting success rates for big game animals.

Activity: channelizing waterways.

Impact: harvest, change in level.

Skovlin, J.M., and R.W. Harris. 1970. Management of conifer woodland grazing resources for cattle, deer, and elk. Int. Grassland Cong. Proc. 11:75-78. (HD)#

Effects of cattle management systems and levels of stocking on herbage production and forage use relationships with deer and elk were investigated. Deferred-rotation grazing at a light stocking rate increased production of Carex geyeri. There was little difference between levels and systems on intermingled grassland openings, but forested areas were improved by a deferred-rotation system. Elk use decreased as the level of cattle stocking increased. C. geyeri was the most abundant and valuable forage species for elk and cattle. There was no significant difference in the amount of deer use among the levels of stocking by cattle, nor was deer use greater in the game-only than in the dual-use ranges. However, deer used the forest in the game-only ranges more than the forest of dual-use ranges. A related response was that, as intensity of cattle grazing increased, deer appeared to make greater use of the grassland openings. Deer tended to prefer deferred- rotation over season-long ranges; however, the difference was significant only at the 10% probability level.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from; vegetation composition, change to less preferred or useable species.

Skovlin, J.M., P.G. Edgerton, and R.W. Harris. 1968. The influence of cattle management on deer and elk. Trans. N. Am. Wildl. Conf. 33:169-181. (GD)#*

Forage use relationships of deer, elk, and cattle were studied on a ponderosa pine-bunchgrass summer range in the central Blue Mountains of northeastern Oregon. Long-term deer use averaged 7 days per ha (2.8 days per ac); elk use averaged 3.75 days per ha (1.5 days per ac); and overall cattle use averaged 9.5 days per ha (3.8 days per ac). Use varied from year to year but showed similar trends for deer and elk. Annual use depended on snow accumulation.

Deer consistently preferred the forested areas over grassland openings, but elk showed no preference. On ranges where cattle were not grazing, elk did show preference to the forest.

Although average deer and elk use was greater in game-only ranges than in dual-use ranges, the difference was significant for elk but not for deer. Elk use decreased as the rate of cattle stocking increased; the rate of stocking had little influence on use by deer. Deer, however, tended to use grasslands more as the rate of stocking increased.

Deer preferred deferred-rotation ranges somewhat more than season-long ranges, but neither system had much effect on use by elk. However, elk preferred season-long ranges at the light rate and deferred-rotation at the heavy rate.

Based on animal requirement, big game consume about 25% of the total forage removed. However, based on forage utilization, cattle were estimated to remove at least 10 times more of the principal plants than deer and elk.

There was no evidence of direct competition between big game and cattle for any particular food plants on the study area.

From the standpoint of total resource management and protection, conservative cattle stocking between the light and moderate level would give good overall production from these multiple-use ranges.

Activity: grazing.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Smith, R.B. 1979. History and current status of Sitka black-tailed deer in the Kodiak archipelago. Pages 184-195 in O.C. Wallmo and J.W. Schoen, eds. Sitka black-tailed deer: proceedings of a conference in Juneau, AK. USDA, Forest Service, Alaska Region, Juneau. (HD)#

This paper includes a description of the vegetation on the Kodiak archipelago and reviews the history of the deer transplant and population trends. Deer- habitat relationships and food habits are also discussed. This paper contains a section describing deer mortality factors, among which is predation by domestic dogs. Predation and chasing by dogs accounts for an undetermined number of deer mortalities. Packs of free-roaming dogs are especially common near the town of Kodiak and other human settlement areas. Most deer-dog incidents occur when snowfall brings deer to low elevations. Management and harvest characteristics are analyzed and summarized. The author suggests that competition with cattle for browse and increasing human encroachment in the form of settlement will continue to reduce habitat. With changes in land ownership, further pressure on deer habitat could come from an accelerated logging program with extensive clear-cuts.

Activity: clearing and tree harvest; grading/plowing; grazing; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); introduced wild or domestic species, competition with or disease transmission from; parasitism and predation, increased susceptibility to; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: clearing and tree harvest; grading/plowing; grazing; human disturbance; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; parasitism and predation, increased susceptibility to; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Stuht, J. 1985. Penn State five wire deer fence. Letter to A.G. Ott, ADF&G, from Dept. of Natural Resources, Lansing, MI. 6 pp. (ADF&G-F)*

This field research letter and set of specifications describes fences that block the movements of white-tailed deer of all life stages. White-tailed deer are related to Sitka black-tailed deer and are expected to respond similarly to fences. Although Michigan is at a more southerly latitude than Alaska, its continental climate results in habitat types similar to those of Interior, but not of Southeast Alaska: northern coniferous and mixed forests with muskegs and bogs in poorly drained areas. The habitat differences between Michigan and Southeast Alaska are not expected to affect the response of deer to fences. The activity of fencing was responsible for the documented direct impact of barriers to movement. Conclusive results were that the Penn State five-wire electric deer fence blocked deer movement except during the winter. Yarding deer passed through the fence even though a high voltage bi-polar charger was used. The bi-polar charger provided power to all wires of the fence in an alternating pattern of positive and negative charge so that any wire would shock a grounded deer and both wires of any pair would shock an ungrounded deer. Construction details for the fence are provided in the letter and are summarized in the annotation for Wingard and Palmer 1982.

Activity: fencing.

Impact: barriers to movement, physical and behavioral.

Taber, R.A., and T.M. Hanley. 1979. The black-tailed deer and forest succession in the Pacific Northwest. Pages 33-52 in O.C. Wallmo and J. W. Schoen, eds. Sitka black-tailed deer: proceedings of a conference in Juneau, AK. USDA, Forest Service, Alaska Region, Juneau. (HD)*

This review article discusses the effects of forest management on Columbian black-tailed deer in the portions of its range extending from northern California to southern British Columbia. Studies of winter and summer range are included. Deer use of coniferous forest habitats for winter range is similar to the situation in Alaska, especially in years of heavy snow accumulation in the northwest. The longer history of forest management in this area illustrates potential future conflicts for Alaska. Activities responsible for the impacts are clearing and tree harvest and chemical application. Impacts documented by reviewed papers are attraction to artificial food sources (direct), vegetation composition change (indirect), and vegetation damage/destruction due to mechanical removal or contact with chemicals (indirect). Conclusive results indicate that widespread replacements of uneven-aged "overmature" lowland coniferous forests by even-aged managed stands has reduced winter forage for deer. Deer strongly prefer forage available in small rather than large openings. Also, the small home ranges of deer result in few deer finding large clear-cuts, and snow accumulation makes forage unavailable in the latter in heavy snow years. After clear-cutting, forage quality decreases, the opposite of what occurs after fire. More intensive forest management by nitrogen fertilization increases the rate of canopy closure and decreases the length of time browse plants can live. If herbicides are used to decrease competition between conifer seedlings and shrubs, browse is severely reduced. Fertilized conifer seedlings are nutritionally attractive to deer, especially when alternative browse is unavailable. A potential direct impact, documented only for elk, is logging slash as a physical barrier to movement and use of cut areas.

Suggestions for mitigation include the following: 1) develop land use plans to optimize the pattern and ratios of habitat types providing forage, cover, and water, including land unsuitable for timber production (e.g., due to low-site quality, riparian zone, roadside, or utility corridor); 2) use precommercial or commercial thinning (just beginning to be widely practiced) to open even-aged stands; 3) grow lure (forage) crops to decrease browsing damage to conifer seedlings; and 4) test shorter rotation periods for clear-cuts (understory response unknown).

[Reviewers note: No other papers (e.g., Regelin 1979, Schoen and Wallmo 1979, Schoen et al. 1983) suggest shortening rotation periods. All other recommendations are to avoid cutting old-growth stands and if they must be cut to use very long rotation periods (greater than 200 yr) to allow the canopy to open and understory shrubs to develop.]

Activity: chemical application; clearing and tree harvest.

Impact: attraction to artificial food source; vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to air pollution or contact with petroleum products; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Vogel, W.O. 1983. The relationship of white-tailed deer and mule deer to agriculture in the Gallatin Valley. Statewide wildlife research project, 1982-1983. Montana Fish and Game Dept., Fed. Aid in Wildl. Rest. Job final rept. Proj. W-120-R-14, Program I, Study No. BG-2.0. Helena. 86 pp. (ADF&G-F)*

In this field research paper, mule deer and white-tailed deer of all life stages were studied from March 1981 through August 1982 in the Gallatin Valley, Montana. Mule deer are closely related to Sitka black-tailed deer, but white-tailed deer differ in some aspects of behavior and habitat use. Although the study area is located south of Alaska, the high elevation of this northern Rocky Mountain valley compensates for the latitude, resulting in habitat types similar to those in parts of Alaska: coniferous and deciduous forests, riparian areas dominated by alder and willow, and grasslands. Interactions of deer with agricultural land (producing hay, small grains, potatoes, and alfalfa) and towns are emphasized - information that is not available for deer range in Alaska, where such extensive development has not yet occurred. The activities of clearing and tree harvest, fencing, grading/plowing, human disturbance, and transporting personnel/equipment/material by land were responsible for the documented direct impacts of attraction to an artificial food source (hay and grains), barriers to movement (densely populated areas), collision with vehicles, active and passive harassment (by dogs and humans), change in harvest level (poaching and dogs), increased susceptibility to predation (killing of fawns by dogs), and the indirect impact of vegetation damage or destruction due to mechanical removal. Conclusive results were that mule deer are less tolerant, behaviorally and physiologically, of disturbance than are white-tailed deer and are being replaced by the latter in the study area. Mule deer make greater use of haystacks, which supplement natural foods in winter and spring, than do white-tails. Deer avoided gravel roads to distances of 300 m (984 ft), paved roads to 600 m (1,968 ft), and an interstate highway to 2.4 km (1.5 mi). A linear relationship was found between degree of avoidance and distance from human disturbance, without evidence of a critical distance. An exponential relationship was found between avoidance and housing density, with very little deer use at 7.8 or more houses per km^2 (20 or more per mi^2). Management recommendations include the following: 1) to deter feeding on haystacks by deer, stack hay close to houses and far from cover, avoid loose stacks or line such stacks up in rows rather than clumps, and stack rectangular bales rather than leaving them scattered; 2) winter deer concentration areas should not be developed; 3) to decrease collisions, drive slower across creeks at night, mark and fence crossings, and control deer numbers through harvest; and 4) limit new housing developments to a few places with small acreage lots close to towns and far from cover and streams, where current density has virtually excluded deer.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); harvest, change in level; parasitism and predation, increased susceptibility to; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Wallmo, O.C., and J.W. Schoen. 1980. Response of deer to secondary forest succession in Southeast Alaska. Forest Sci. 26(3):448-462. (HD)#

Uneven-aged silviculturally overmature stands of western hemlock-Sitka spruce (Tsuga heterophylla-Picea sitchensis) forest in Southeast Alaska were used more heavily by Sitka black-tailed deer (Odocoileus hemionus sitkensis) than adjacent or nearby comparison areas that had been clear-cut, regardless of their postlogging age. Mean ratios of use, comparing overmature forest to young growth, were 5.3:1 in summer and 7.0:1 in winter. Overmature stands ranged in age from 30 to 147 yr. Similar results from Vancouver Island, B.C., are reviewed. Elsewhere, little attention has been given to the quality of climax coniferous forest as deer habitat relative to that of seral forest. It is concluded that even-age management of coniferous forest in the areas studied, and perhaps more generally, will result in a significant decrease in carrying capacity of deer.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Wingard, R.G., and W.L. Palmer. 1982. Control methods to reduce deer damage to Pennsylvania agriculture. School of Forest Resources, College of Agriculture Final Rept., July 1, 1981 to June 30, 1982. Univ. Penn. 15 pp. plus Appendices. (ADF&G-F)*

In this field research report, the effects of chemical deer repellents and of fences on browsing of crop plants by white-tailed deer of all life stages in Pennsylvania were studied during all seasons of the year between July 1, 1981 and June 30, 1982. White-tailed deer are similar enough to Sitka black-tailed deer that comparable responses to fencing and to chemical repellents would be expected. Although the habitat types of eastern deciduous and mixed forests, orchards, and cultivated fields are not similar to the coastal forests of Alaska where Sitka black-tailed deer occur, the habitat type is not crucial to the responses to fencing and repellents. The activity of plowing (farming) was responsible for the documented direct impact of attraction to crops, the activity of fencing was responsible for the documented direct impact of barriers to movement, and the activity of chemical application was responsible for the documented indirect impact of vegetation damage (in terms of palatability to deer) due to chemicals. Conclusive results showed that although in some cases commercially available chemical deer repellents greatly decreased winter browsing on dormant twigs of trees and shrubs, consistent results were not obtained and the results did not justify the cost of treating the plants. Deer were attracted to vegetable gardens, alfalfa, fruit tree orchards, grain fields, and coniferous tree farms. The Penn State five-wire electric deer fence successfully prevented deer from entering fields and consuming attractive crops, even where they had done so before the fence was built. Cost:benefit ratios for the first year of use ranged from 2:1 to more than 1:10. The fence is expected to last about 30 yr. Specifications for the recommended fence can be summarized as follows. The fence is made of five 12½-gauge high-tensile wires, the lowest 25 cm (10 in) from the ground, the rest spaced 30.5 cm (12 in) apart, for a total height of 1.5 m (58 in). The wires are strung on insulating posts or clips, tensioned to 1.11 kN (250 lb), and ends are joined by crimping sleeves rather than knots. Special accessories maintain the high tension. A high-voltage, low-impedance energizer (e.g., Gallagher New Zealand style) is necessary to maintain consistent high voltage on the fence. Alternate wires should be grounded so that the fence is effective in subfreezing weather. Maintenance of the 25-cm (10-in) lower wire to ground distance is essential to preventing deer from crawling under the fence. Low spots and gulleys must be filled. Long straight runs of fence are essential to avoid the cost of large diameter (more than 7.6 cm [3 in]) posts and special bracing on curves. A strip 1.8-2.4 m (6-8 ft) wide outside the fence must be kept clear of trees and shrubs, so that deer will learn to stay 0.9-1.2 m (3-4 ft) from the fence after having been shocked when they tried to go through it and not get close enough to jump over it. Grass and shrubs must be kept from touching the wires, or the voltage will decrease and the deer will perceive the fence as a solid barrier to be jumped over.

[Reviewer's note: in contrast to these authors, McAninch et al. 1983 do recommend the use of deer repellents under certain conditions and describe the frequency of application needed.]

Activity: chemical application; fencing; grading/plowing.

Impact: attraction to artificial food source; barriers to movement, physical and behavioral; vegetation damage/destruction due to air pollution or contact with petroleum products.

Young, S. [1955?]. Exclosures in big game management in Utah. Photocopy. 5 pp. (ADF&G-F)*

This field research report discusses the effects of livestock grazing and of fencing on mule deer of all life stages throughout the state of Utah. Mule deer are closely related to Sitka black-tailed deer and are expected to respond in essentially the same way to fencing and in comparable ways to grazing. The exclosures used for the study had been built between 1932 and 1954 and maintained during all seasons of the years between construction and evaluation in 1954. Although the habitat types of cold desert and shortgrass prairie are not comparable to habitats of black-tailed deer in Alaska, responses of deer to grazing and especially to fencing are expected to be similar. The activity of grazing was responsible for the documented indirect impact of vegetation damage and destruction due to grazing by domestic animal, and that of fencing was responsible for the documented direct impact of barriers to movement. Moderate-to-heavy spring, summer, and fall use of shortgrass prairie deer range by domestic cattle conclusively resulted in decreased ground cover, fewer grasses, and fewer desirable forb species compared to areas protected from grazing by cattle. Fencing at least 2.4 m (8 ft) high is recommended to block deer movement. To allow deer to pass over fences but block cattle, fences should be 0.9 to 1.1 m (3 to 3.5 ft) high and railed. Where deep snows prevail, log and block fencing should be used instead of less durable wire fencing. Deer were reluctant to enter fenced areas of 0.1 ha (0.25 ac) or less and were least deterred by fenced areas larger than 0.4 ha (1 ac).

Activity: fencing; grazing.

Impact: barriers to movement, physical and behavioral; vegetation damage/destruction due to grazing by domestic or introduced animals.

15. Bald Eagle

Table 2. Impacts Associated With Each Activity - Bald Eagle

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove																														
Aquatic vegetation, destruction or change																														
Attraction to artificial food source													X									X								X
Barriers to movement, physical and behavioral																														
Collision with vehicles or structures																											X	X		
Entanglement in fishing nets, debris																						X								
Entrapment in impoundments or excavations																														
Harassment, active or passive	X	?	?		X		?					X		X	?			?	?	?							X	X	X	
Harvest, change in level																														
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				X														?	X	X	?				?	?		?	?	
Parasitism/predation, increased susceptibility																														
Prey base, alteration of			?	?			?			?				?				?	?	?	?				?	?		?	?	?
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction	?											?																		
Veg. composition, change to less preferred		?		?	?						?																			
Veg. damage/destruction due to air pollution				?																										
Veg. damage/destruction due to fire/parasitism		?																												
Veg. damage/destruction due to grazing																														
Veg. damage/destruction due to erosion					X																									
Water level or water quality fluctuations			?				?			?	?				?			?	?	?	?									?

X - Documented impact (see text).
? - Potential impact.

15. BALD EAGLE - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on Bald Eagle. Each citation refers to an annotation in the following section, Annotated References to Impacts on Bald Eagle. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to Bald Eagle are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to Bald Eagle were found for the following activities:

- Burning
- Channelizing waterways
- Draining
- Dredging
- Drilling
- Fencing
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Log storage/transport
- Netting
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Sewage disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - land, ice
- Transport of oil/gas/water - water

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Snow 1973
      U.S. Army Corps of Engineers 1979

2. Chemical application:

   a. Morbidity/mortality by ingestion of petroleum

      Coon et al. 1970
      Evans 1982
      Olendorff et al. 1981
      Redig et al. 1983
      Snow 1973
      Sopuck et al. 1979
      U.S. Army Corps of Engineers 1979

3. Clearing and tree harvest:

   a. Harassment, active or passive

      Corr 1974
      Hansen 1977
      Hansen et al. 1980
      Sopuck et al. 1979
      Thelander 1973

   b. Veg. damage/destruction due to erosion

      Corr 1974
      Hansen et al. 1980
      Hodges et al. 1984
      Roseneau et al. 1981
      Sigman 1985
      Snow 1973
      Sopuck et al. 1979
      Stalmaster 1980
      U.S. Army Corps of Engineers 1979

4. Grading/plowing:

   a. Harassment, active or passive

      Hansen 1977

5. Grazing:

   a. Attraction to artificial food source

      Klebesadel and Restad 1981
      McEneaney and Jenkins 1983

6. Human disturbance:

   a. Harassment, active or passive

      Bangs et al. 1982
      Bangs et al. 1982
      Grier 1969
      Grubb 1976
      Hansen 1977
      Hansen et al. 1984
      Roseneau et al. 1981
      Sherrod et al. 1976
      Skagen 1980
      Snow 1973
      Sopuck et al. 1979
      Stalmaster 1980
      Stalmaster and Newman 1978
      Steenhof 1978
      Thelander 1973
      U.S. Army Corps of Engineers 1979

7. Processing minerals (including gravel):

   a. Morbidity/mortality by ingestion of petroleum

      Evans 1982
      Snow 1973
      U.S. Army Corps of Engineers 1979

8. Processing oil/gas:

   a. Morbidity/mortality by ingestion of petroleum

      Coon et al. 1970
      Evans 1982
      Snow 1973
      U.S. Army Corps of Engineers 1979

9. Solid waste disposal:

   a. Attraction to artificial food source

      Musselman 1949
      Roseneau et al. 1981
      Sherrod et al. 1976

   b. Entanglement in fishing nets, debris

Redig et al. 1983

10. Transport of personnel/equipment/material - air:

    a. Collision with vehicles or structures

        Roseneau et al. 1981

    b. Harassment, active or passive

        Hansen et al. 1984
        Roseneau et al. 1981
        Sherrod et al. 1976
        Sopuck et al. 1979
        USDI 1976a
        White and Sherrod 1973

11. Transport of personnel/equipment/material - land, ice:

    a. Collision with vehicles or structures

        Boeker and Nickerson 1975
        Coon et al. 1970
        Evans 1982
        Olendorff et al. 1981
        Redig et al. 1983
        Reiswig 1981
        Sherrod et al. 1976
        Snow 1973
        Sopuck et al. 1979
        Steenhof 1978
        U.S. Army Corps of Engineers 1979

    b. Harassment, active or passive

        Hansen 1977
        Skagen 1980
        Snow 1973
        Sopuck et al. 1979
        Stalmaster 1980
        Steenhof 1978

12. Transport of personnel/equipment/material - water:

    a. Harassment, active or passive

        Bangs et al. 1982

Bangs et al. 1982
Hansen et al. 1984
Knight and Knight 1984
Russell 1980
Snow 1973
Sopuck et al. 1979
Stalmaster 1980
Steenhof 1978
U.S. Army Corps of Engineers 1979

13. Water regulation/withdrawal/irrigation:

a. Attraction to artificial food source

Musselman 1949

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to Bald Eagle were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Barriers to movement, physical and behavioral
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Parasitism/predation, increased susceptibility
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Grazing

      Klebesadel and Restad 1981
      McEneaney and Jenkins 1983

   b. Solid waste disposal

      Musselman 1949
      Roseneau et al. 1981
      Sherrod et al. 1976

   c. Water regulation/withdrawal/irrigation

      Musselman 1949

2. Collision with vehicles or structures:

   a. Transport of personnel/equipment/material - air

Roseneau et al. 1981

b. Transport of personnel/equipment/material - land, ice

Boeker and Nickerson 1975
Coon et al. 1970
Evans 1982
Olendorff et al. 1981
Redig et al. 1983
Reiswig 1981
Sherrod et al. 1976
Snow 1973
Sopuck et al. 1979
Steenhof 1978
U.S. Army Corps of Engineers 1979

3. Entanglement in fishing nets, debris:

a. Solid waste disposal

Redig et al. 1983

4. Harassment, active or passive:

a. Blasting

Snow 1973
U.S. Army Corps of Engineers 1979

b. Clearing and tree harvest

Corr 1974
Hansen 1977
Hansen et al. 1980
Sopuck et al. 1979
Thelander 1973

c. Grading/plowing

Hansen 1977

d. Human disturbance

Bangs et al. 1982
Bangs et al. 1982
Grier 1969
Grubb 1976
Hansen 1977

Hansen et al. 1984
Roseneau et al. 1981
Sherrod et al. 1976
Skagen 1980
Snow 1973
Sopuck et al. 1979
Stalmaster 1980
Stalmaster and Newman 1978
Steenhof 1978
Thelander 1973
U.S. Army Corps of Engineers 1979

e. Transport of personnel/equipment/material - air

Hansen et al. 1984
Roseneau et al. 1981
Sherrod et al. 1976
Sopuck et al. 1979
USDI 1976a
White and Sherrod 1973

f. Transport of personnel/equipment/material - land, ice

Hansen 1977
Skagen 1980
Snow 1973
Sopuck et al. 1979
Stalmaster 1980
Steenhof 1978

g. Transport of personnel/equipment/material - water

Bangs et al. 1982
Bangs et al. 1982
Hansen et al. 1984
Knight and Knight 1984
Russell 1980
Snow 1973
Sopuck et al. 1979
Stalmaster 1980
Steenhof 1978
U.S. Army Corps of Engineers 1979

5. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Coon et al. 1970
Evans 1982

Olendorff et al. 1981
Redig et al. 1983
Snow 1973
Sopuck et al. 1979
U.S. Army Corps of Engineers 1979

b. Processing minerals (including gravel)

Evans 1982
Snow 1973
U.S. Army Corps of Engineers 1979

c. Processing oil/gas

Coon et al. 1970
Evans 1982
Snow 1973
U.S. Army Corps of Engineers 1979

6. Veg. damage/destruction due to erosion:

a. Clearing and tree harvest

Corr 1974
Hansen et al. 1980
Hodges et al. 1984
Roseneau et al. 1981
Sigman 1985
Snow 1973
Sopuck et al. 1979
Stalmaster 1980
U.S. Army Corps of Engineers 1979

ANNOTATED REFERENCES TO IMPACTS TO BALD EAGLES

The annotated bibliography contains only references that discuss documented impacts to Bald Eagles. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to Bald Eagles are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Bangs, E.E., T.N. Bailey, and V.D. Berns. 1982. Ecology of nesting Bald Eagles on the Kenai National Wildlife Refuge, Alaska. Pages 47-54 in W.N. Ladd and P.F. Schempf, eds. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. USDI: FWS, Alaska Regional Office, Anchorage, AK. (UAF)

This field study examined the nesting ecology and productivity of Bald Eagles on and near the Kenai National Wildlife Refuge during May through August 1979 and 1980. The habitat type of the study area was lowland boreal forest associated with rivers and lakes. The activities of human disturbance and transport of personnel/equipment/material by water produced a tentative documented direct impact of passive harassment. Human disturbance appeared to negatively influence reproductive success of eagles. Eagles with nests that probably experienced some human disturbance produced fewer eaglets than did eagles with nests suspected of having little disturbance. Quantitative measurements or documentation of actual disturbance to eagles were not recorded or presented.

Activity: human disturbance; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Bangs, E.E., T.H. Spraker, T.N. Bailey, and V.D. Berns. 1982. Effects of increased human populations on wildlife resources of the Kenai Peninsula, Alaska. Trans. N. Am. Wildl. Nat. Resour. Conf. 47:605-616. (UAF)

This paper reviews the historical impacts, management techniques and potential human impacts on trumpeter swans, Bald Eagles, salmon, wolves, caribou, and moose on the Kenai Peninsula, Alaska. The information reviewed dates to the early 1900's, although the majority of the impact-related information is from the 1960's and 1970's. Habitat types in the area range from coastal forest to alpine tundra.

Trumpeter swans. The activity of human disturbance produced the direct documented and potential impacts of active and passive harassment. Human disturbance associated with residential and industrial development was suspected to have caused abandonment of a spring staging area and several nest sites. Continued disturbance was expected to occur with further human development within the area.

Bald Eagle. The activities of human disturbance and transporting personnel/equipment/material by water produced documented direct impacts of active and passive harassment. Eaglet production was substantially less in areas subjected to human disturbance than in areas subjected to little disturbance. Potential impacts that may be associated with roads and transmission lines from the Bradley Lake power project include electrocution from contact with powerlines and passive harassment.

Moose. The activities of human disturbance and transporting personnel/equip- ment/material by land resulted in direct, documented impacts of moose colliding with vehicles and increased susceptibility to predation. Conclusive results show that between 1970 and 1980 an average of 150 moose were killed annually by colliding with vehicles, and that an undetermined number of calves were killed by domestic dogs.

Wolves. The activities of human disturbance and processing minerals resulted in direct, documented impacts of disease transmission from domesticated animals, passive harassment, and drastically increased harvest. By 1915, widespread use of poison and unregulated hunting and trapping had extirpated wolves from the Kenai Peninsula. After recolonization, it is believed that at least one wolf pack has been reduced by contracting distemper from domestic dogs. Intensively developed lands, which wolves avoid, have reduced wolf habitat on the Kenai Peninsula.

Activity: human disturbance; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Boeker, E.L., and P.R. Nickerson. 1975. Raptor electrocutions. Wildl. Soc. Bull. 3(2):79-81. (UAF)

Raptor deaths by electrocution on powerlines were documented in this review paper for the years 1972 and 1973. Documented losses by state for Bald and golden eagles, red-tailed hawks, and great horned owls were listed. No losses were listed for Alaska. Habitat types were not listed in the article. The activity of transporting personnel/equipment/material by land produced a documented direct impact of electrocution through contact with powerlines. Two-hundred-fifty Bald Eagles were documented to have been killed by electrocution in 1972 and 1973. Smaller distribution lines were most likely to cause electrocution of eagles, as the distance between phase conductors and grounds were easily spanned by the eagle's large wingspan. High voltage transmission lines, with a large distance between phase conductors, cause few, if any, electrocutions.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Coon, N.C., L.N. Locke, E. Cromartie, and W.L. Reichel. 1970. Causes of Bald Eagle mortality, 1960-1965. J. Wildl. Dis. 6(1):72-76. (UAF)#

Residue levels of organochlorine pesticides allow only speculation that sublethal accumulations are causing direct Bald Eagle mortalities. The greatest cause of mortality (45 of 76 documented deaths) was shooting. One was electrocuted.

Activity: chemical application; processing oil/gas; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; morbidity or mortality due to ingestion of or contact with petroleum.

Corr, P.O. 1974. Bald Eagle (Haliaeetus leucocephalus alaskanus) nesting related to forestry in Southeastern Alaska. M.S. Thesis, Univ. Alaska, Fairbanks. 144 pp. (UAF)*

This field study examines the relationships of Bald Eagle nesting to forestry practices near Petersburg, Alaska, during 1967-1969. Habitat types within the study area were both logged and unlogged beach frontage within old-growth coniferous forests containing primarily western hemlock and Sitka spruce. The activity of tree harvest produced a documented direct impact of harassment and documented direct and indirect impacts from vegetation damage/destruction due to mechanical removal. Tree harvest reduced the number of available nest sites within the study area, and temporarily caused eagles to leave the immediate area of logging. Suitable nest trees left standing in beach fringe timber and any nests constructed in these trees were vulnerable to windthrow during heavy storms. Management recommendations were 1) to maintain buffer zones with a 200 m (660 ft) radius around eagle nests, 2) to curtail logging activity during April and May in the vicinity of nesting eagles, and 3) that small, scattered timber sales be promoted to ensure that extensive beach strip tree harvest does not remove potential nest sites along miles of shoreline.

Activity: clearing and tree harvest.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Evans, D.L. 1982. Status reports on twelve raptors. USDI, USFWS, special rept., Wildl. No. 238. Washington, D.C.#

This paper provides a brief status report on Bald Eagles. Human-related mortality factors are surveyed. Pesticides are one such factor. They may result in outright mortality or in lower productivity. Both DDT and dieldrin have been known to cause direct mortality; DDT and its metabolites cause egg shells to be thinner, and when a certain level of the pesticide is reached incubation failure results. Dieldrin, PCBs, and mercury compounds have been linked to embryonic and early chick mortality.

Illegal shooting is the greatest single known cause of adult or subadult Bald Eagle mortality. Other causes include electrocution, trapping, automobile or train accidents, and poisoning.

Activity: chemical application; processing minerals (including gravel); processing oil/gas; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; morbidity or mortality due to ingestion of or contact with petroleum.

Grier, J.W. 1969. Bald Eagle behavior and productivity responses to climbing to nests. J. Wildl. Manage. 33(4):961-966. (UAF)

This field study was conducted in northwestern Ontario, Canada, during the Bald Eagle nesting seasons of 1966-1968 to measure the productivity and behavior of Bald Eagles in response to climbing nests to band eaglets. Habitat within the study area was dominated by a lake- and river-studded boreal forest containing mixed stands of spruce, pine, and aspen. Although species composition is somewhat different, the habitat type within this study area is quite similar to that used by Bald Eagles in portions of Alaska. The activity of human disturbance produced a documented direct impact of active harassment. Adult eagles circled overhead and occasionally dove at the author while he was climbing to the nest. Reactions of eaglets varied, ranging from no reaction to jumping from the nest. Eaglet reaction varied with age, with older eaglets reacting most strongly. Conclusive results indicated that productivity of Bald Eagles was not affected by climbing to nests when the young were between 2 and 11 weeks old.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Grubb, T.G. 1976. Nesting Bald Eagles attack researcher. Auk 93(4):842-843. (UAF).

This short field note describes an incident where two adult Bald Eagles attacked and struck the author while he was climbing to the eagle's nest on July 20, 1968. The nest was located in a cottonwood tree on Kodiak Island. The activity of human disturbance produced a documented direct impact of active harassment.

Activity: human disturbance.

Impact: harassment.

Hansen, A.J. 1977. Population dynamics and night roost requirements of Bald Eagles in the Nooksack River Valley, Washington. Huxley College of Environ. Studies, Bellingham, Washington. 26 pp.#

This paper describes Bald Eagle roosting habitat and its use along the Nooksack River in northcentral Washington State. Of interest is use of a roost half of which had been clear-cut the previous summer. Another instance where a road was built and used by recreational vehicles and where logging occurred nearby apparently resulted in decreased use of the immediate vicinity by Bald Eagles. One roost was in large second-growth Douglas fir. Human disturbance was tolerated more at roosts than at feeding areas. Daily activities of small numbers of humans living within 500 m (1,650 ft) of one roost seemed to be unimportant to the eagles.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Hansen, A.J., M.V. Stalmaster, and J.R. Newman. 1980. Habitat characteristics, function and destruction of Bald Eagle communal roosts in western Washington. Pages 221-229 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, eds. Proceedings of the Washington Bald Eagle symposium, Seattle, WA. (ADF&G-F)

This field study, conducted from October to March 1975-1979 on two river systems in western Washington, investigated the behavior, habitat requirements, and roosting behavior of Bald Eagles. The habitat type found in the study area was coniferous forest dominated by Douglas fir or western red cedar, similar to that found in portions of Alaska. The activity of clearing and tree harvest produced documented direct impacts of passive harassment and vegetation damage/destruction due to mechanical removal. Noise from tree harvest adjacent to a roost caused eagles to leave the roost earlier each day than normal. Following removal of all trees in one roost, eagles were not observed roosting in trees around the perimeter of the clearcut during the following two winters.

Activity: clearing and tree harvest.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Hansen, A.J., E.L. Boeker, J.I. Hodges, and D.R. Cline. 1984. Bald Eagles of the Chilkat Valley, Alaska: ecology, behavior, and management. Final rept. of the Chilkat River Cooperative Bald Eagle Study. National Audubon Society and USFWS. (ADF&G-F, Habitat)

The purpose of this field study was to determine the factors limiting Chilkat Bald Eagles and the birds' adaptations to those limiting factors. This four-year study, begun in 1980, was conducted in the Chilkat and Chilkoot river valleys, Alaska. The Chilkat River is glacial and braided in its lower reaches and is bordered by riparian stands of cottonwood, Sitka spruce, and western hemlock. The Chilkoot River is also glacial but is not braided. Both rivers have large runs of salmon in fall. The activities of human disturbance and transporting personnel/equipment/material by air and water produced a documented direct impact of passive harassment. People moving across the feeding grounds typically caused eagles to shift temporarily to another portion of the feeding grounds. Aircraft landing on gravel bars, low-flying helicopters, noisy or sustained boat traffic, or frequent human presence on gravel bars resulted in most eagles evacuating the feeding grounds to seek refuge in the off-river conifer roosts. Recommendations were to minimize human activity near nests and feeding areas, to protect streamside forests used by eagles for perching, nesting, and roosting, and to maintain salmon-spawning and rearing habitat.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment.

Hodges, J.I., Jr., J.G. King, and R. Davies. 1984. Bald Eagle breeding population survey of coastal British Columbia. J. Wildl. Manage. 48(3): 993-998. (UAF)

This field study, conducted during April and May 1980, was designed to provide an estimate of the breeding Bald Eagle population of coastal British Columbia by way of aerial surveys. Habitat within the survey area was numerous islands and fjord-laced coastline covered by coastal coniferous forest. The activity of clearing and tree harvest produced a documented direct impact of vegetation damage/destruction due to mechanical removal. Adult eagles and active nests were far less abundant in disturbed habitat containing no remnant old-growth trees (e.g., clear-cuts or even-aged second growth) than the relative abundance of that habitat. If the disturbed habitat contained some remnant old-growth trees, adults and active nests were present in greater than expected numbers. Older hand-logged areas (pre-1940) contained some remnant old-growth trees that provided limited nesting and perching sites, as opposed to modern clear-cut techniques, which remove all trees.

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion or deposition, mechanical removal, or material overlay.

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

In this review article, the interactions between agriculture and wildlife are discussed. The species include bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the contiguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine, during white settlement is attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain-growing areas in Alaska in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep, and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grazing.

Impact: attraction to artificial food source.

Knight, R.L., and S.K. Knight. 1984. Responses of wintering Bald Eagles to boating activity. J. Wildl. Manage. 48(3):999-1,004. (UAF)*

This field study was conducted along the Skagit and the north fork of the Nooksack rivers in northwestern Washington from December 1980 through February 1981 and examined the flushing responses and flight distances of wintering Bald Eagles to a canoe on these adjacent rivers with widely disparate levels of boating activity. Habitat within the study area consisted of mixed coniferous and deciduous forest bordering rivers with extensive gravel bars, similar to that found in areas of Alaska. Observations of both adult and subadult eagles were recorded. The activity of transporting personnel/equipment/material by water produced documented direct impacts of active and passive harassment. Conclusive results revealed no differences in flushing responses that were attributable to the age or social grouping of eagles. Eagles perched in trees along the Skagit River (with heavy winter boating activity) flew in response to the researcher's canoe much less than did eagles perched in trees along the Nooksack River (with little winter boating activity). Eagles feeding or standing on the ground flew at greater distances than did those perched in trees at either river. Eagles in groups standing on the ground flew at greater distances than did solitary eagles on the ground or perched in trees and eagles in groups perched in trees at either river. Perched eagles on both rivers showed a decreasing tendency to flush as winter progressed, indicating either habituation to human presence or a reluctance to fly because of decreased food abundance. The authors recommended that 1) an activity-restriction zone of 350 m (1,150 ft) would protect 99% of eagles perched in shoreline trees from disturbance by a single canoe, 2) that an activity-restriction zone of at least 450 m (1,475 ft) would be required to protect 99% of feeding eagles perched on river bars from disturbance from a single canoe, and 3) that boating activities should be restricted during early morning and late evening hours, periods of intense feeding activity for eagles.

Activity: transport of personnel/equipment/material - water.

Impact: harassment.

McEneaney, T.P., and M.A. Jenkins. 1983. Bald Eagle predation on domestic sheep. Wilson Bull. 95(4):694-695. (UAF)

This paper reports conclusive documentation of two instances of Bald Eagle predation on domestic sheep during February 1981 near Woodruff, Utah. No description of habitat was provided in this paper. These observations are applicable to Alaskan eagles, as the potential for sheep and other livestock ranching in Alaska exists near eagle habitat. The activity of grazing produced a documented direct impact of attraction to an artificial food source. One adult eagle attacked and killed an apparently healthy lamb estimated to be four days old. A pregnant ewe was attacked by an adult eagle, and later died, after being fed upon by the attacking eagle and three other eagles.

Activity: grazing.

Impact: attraction to artificial food source.

Musselman, T.E. 1949. Concentrations of Bald Eagles on the Mississippi River at Hamilton, IL. Auk 66:83.#

This paper mentions that Bald Eagles concentrated in winter below packing plants where offal was discarded into the river and below Keokuk Dam, where the water remains open and many fish are killed as they pass through the turbines that create electricity.

Activity: solid waste disposal; water regulation/withdrawal/irrigation.

Impact: attraction to artificial food source.

Olendorff, R.R., A.D. Miller, and R.N. Lehman. 1981. Suggested practices for raptor protection on powerlines: the state of the art in 1981. Raptor Res. Rept. No. 4. Raptor Research Foundation, Inc., Provo, Utah. 111 pp. (UAF)*

This review paper examines the problem of raptor electrocution from powerlines and proposes means to prevent or minimize the danger of powerlines to raptors. References reviewed date to 1922, although the majority are from the 1970's. This paper is primarily oriented towards golden eagles, the most commonly electrocuted raptor, although documentation of deaths by electrocution for Bald Eagles, ospreys, owls, and several species of hawks are discussed. The papers reviewed were most commonly of studies conducted in the western United States. Habitat types for individual studies were not described. The activities of transporting personnel/equipment/material by land and chemical application produced documented direct impacts of electrocution by powerlines and mortality due to ingestion of chemicals, respectively. Eleven Bald Eagle deaths in 1971 were attributed to ingestion of poisoned carcasses used for predator control. Recommendations are proposed to minimize or eliminate electrocution hazards (a detailed section on powerline and powerpole construction), impacts of construction and line maintenance, collision hazards, and harassment. Annotations are provided for each cited reference.

Activity: chemical application; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; morbidity or mortality due to ingestion of or contact with petroleum.

Redig, P.T., G.E. Duke, and P. Swanson. 1983. The rehabilitation and release of Bald and golden eagles: a review of 245 cases. Pages 137-147 in D.M. Bird, ed. Biology and management of Bald Eagles and ospreys. Proceedings of the first international symposium on Bald Eagles and ospreys, Montreal, October 28-29, 1981. Ste. Anne de Bellevue, Quebec: Harpell Press. 325 pp. (ADF&G-F, Habitat)

This paper reports on the clinical treatment, release, and postrelease survival of Bald and golden eagles between 1972 and 1982 that were brought to the University of Minnesota after traumatic injuries. Injured eagles were from the midwestern United States. Although plant species composition is substantially different between the midwestern United States and Alaska, habitat structure used by eagles (e.g., fish-bearing lakes and rivers in timbered areas) is similar enough to justify inclusion. Habitat from which each injured eagle was removed was not described. The activities of chemical application, transporting personnel/equipment/material by land, and solid waste disposal produced documented direct impacts of ingestion of chemicals, collision with vehicles and powerlines, and entanglement in wire. A large number of eagles were injured or killed in traps or shooting. One eagle died from eating a strychnine-killed pigeon near an airport where a poorly monitored pigeon-poisoning program was underway. Additional eagles were found with varying degrees of lead poisoning. Collision with vehicles produced the highest death rate of eagles. Nearly twice as many immature as adult Bald Eagles were treated for injuries.

Activity: chemical application; transport of personnel/equipment/material - land; solid waste disposal.

Impact: collision with vehicles or structures, or electrocution by powerlines; entanglement in fishing nets, marine or terrestrial debris, or structures; morbidity or mortality due to ingestion of or contact with petroleum, petroleum products, or other chemicals.

Reiswig, B. 1981. Movement and breeding biology of Bald Eagles on Adak Island. USFWS, Prog. Rept. 01-01-81 to 11-30-81, Aleutian Islands Unit, Alaska Region. #

This report notes 50 birds will be killed each year on Adak Island by electrocution from high voltage power lines. Trees do not occur in the Aleutians, and perching sites are far less common than in timbered areas. Mortality has recently been reduced by 50% by the addition of perches on key poles.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Roseneau, D.G., C.E. Tull, and R.W. Nelson. 1981. Protection strategies for peregrine falcons and other raptors along the planned Northwest Alaskan gas pipeline route. Final rept. Vol. 1. Unpubl. rept. by LGL Alaska Res. Assoc., Inc., Fairbanks, for Northwest Alaskan Pipeline Co. and Fluor Northwest, Inc., Fairbanks. 217 pp. (UAF)*

The purpose of this paper was to develop protective strategies to prevent or minimize the impacts of the proposed Northwest Alaskan gas pipeline on nesting raptors. The paper emphasized peregrine falcons, although Bald Eagles, gyrfalcons, rough-legged hawks, golden eagles, and osprey are also treated. Papers reviewed were from studies conducted in Alaska, Canada, and the remainder of the United States. Habitat types from referenced studies were not always described; however, detailed habitat descriptions, particularly for areas used for nesting, are described for each species' range within Alaska. Habitat used by Bald Eagles along the proposed pipeline route within Alaska was boreal forest associated with streams, rivers, lakes, or wetland areas. Activities described in the paper that affected Bald Eagles included human disturbance, solid waste disposal, clearing, and transporting personnel/equip- ment/material by air. Documented impacts associated with these activities included active and passive harassment, attraction to an artificial food source, collision with vehicles, and vegetation destruction due to mechanical removal. Recommendations for protection of Bald Eagles were developed after review of State of Alaska protection criteria and recommendations proposed by various authors for protection of raptors in Alaska and Canada. Recommenda- tions included restrictions on activities near Bald Eagle nests from March 1 to August 31, including prohibition of aerial activity within 0.4 km (¼ mi) or 350 m (1,000 ft) elevation of nests, prohibition of ground activities within 0.4 km (¼ mi) of nests, prohibition of facility siting within 0.8 km (½ mi) of nests and prohibition of habitat disturbance at any time within 0.8 km (½ mi) of nests.

Activity: clearing and tree harvest; human disturbance; solid waste disposal; transport of personnel/equipment/material - air.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Russell, D. 1980. Occurrence and human disturbance sensitivity of wintering Bald Eagles on the Sauk and Suiattle Rivers, Washington. Pages 165-174 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, eds. Proceedings of the Washington Bald Eagle symposium. Seattle, WA. (ADF&G-F)

In this field study conducted between November 1979 and March 1980, wintering Bald Eagles were censused on two northwestern Washington rivers to provide baseline data on numbers and distribution. Concurrent with censusing, tolerance to humans was measured by the flushing response of eagles to the census rubber raft. Habitat type along the rivers was coniferous forest containing varying degrees of human development and activity. The activity of transporting personnel/equipment/material by water produced a documented direct impact of passive harassment. Conclusive results indicated that feeding eagles were most sensitive to disturbance by the census raft; all feeding eagles were flushed by the approaching raft. Flushing of eagles by the raft was most frequent on river stretches with low levels of human activity and least frequent in areas of high human activity, tentatively suggesting that habituation to human activity may have occurred, although other factors may have influenced the differential frequency of flushing.

Activity: transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sherrod, S.K., C.M. White, and F.S.L. Williamson. 1976. Biology of the Bald Eagle on Amchitka Island, Alaska. Living Bird 15:143-182. (ADF&G-F, Habitat).

This paper reports the results of a field study of a resident Aleutian Island population of Bald Eagles inhabiting Amchitka Island, Alaska. Field work was conducted between April 1968 and July 1974, but the most concentrated efforts were conducted between June and August 1972 and between May and June 1973. Aspects of eagle biology studied included population dynamics, movements, food habits and food supply, mortality, and reproduction. All ages and both sexes of eagles were studied. Habitat on Amchitka Island ranges from flat, low-lying treeless areas with numerous shallow lakes to mountains. The shoreline has numerous boulder-covered beaches, cliffs, and offshore seastacks. A wide intertidal or subtidal zone surrounds the island. The activities of solid waste disposal, human disturbance, and transporting personnel/equipment/material by air and land produced documented direct impacts of attraction to an artificial food source, active harassment, and electrocution by powerlines. A garbage dump on the island was used frequently by eagles, particularly by subadults that had not yet perfected their hunting technique. Numbers of subadult eagles were substantially reduced in 1974 after closure of the dump in 1973, indicating the dump was supplementing the food sources of eagles and enabling a greater number of young birds to survive and reach adulthood. Eagles actively and aggressively defended nest sites when approached by investigators on foot or in helicopters. Electrocuted eagles were found beneath some power poles on the island.

Activity: human disturbance; solid waste disposal; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

Sigman, M.J., ed. 1985. Impacts of clearcut logging on the fish and wildlife resources of Southeast Alaska. ADF&G, Div. Habitat, Tech. Rept. 85-3. 95 pp. Juneau. (ADF&G-F)*

This review article discusses the effects of clear-cut logging on Sitka black-tailed deer, mountain goat, moose, brown and black bear, Bald Eagle, marten, mink, land otter, and red squirrel of all life stages, among other species. Most of the papers cited describe research done in Southeast Alaska since 1970, but older publications and studies performed on the same species in other geographic areas where the habitat types and latitude are similar to those of Southeast Alaska are also included. The studies were done at all seasons of the year. The habitat type is coastal temperate rain forest dominated by Sitka spruce, western hemlock, and other conifers. In addition to documented impacts, potential impacts are discussed, and life history and habitat use information is presented for each wildlife species. Only documented impacts and recommendations made in the cited papers are summarized below by species. Management recommendations made by the author are generalizations of those made in the cited papers and are not repeated here.

Sitka black-tailed deer. The activity of clearing and tree harvest was responsible for the documented direct impact of barriers to movement and for the documented indirect impacts of vegetation composition change to less preferred successional stage and vegetation damage or destruction due to mechanical removal. Dense shrubs and slash in clear-cuts less than 15 to 40 years old precludes deer movement and use in summer, and in winter higher snow depths in clear-cuts nearly prevent deer use and movement. Even in winters of little snow accumulation and in summer, deer avoid clear-cuts and prefer mature old-growth forest habitats. Precommercial thinning may prolong understory production in stands prior to canopy closure, but any effect is short-lived and a two-layered conifer stand results. Deer populations have declined by 50 to 75% after clear-cutting of areas on and near Vancouver Island, B.C. Mitigation recommendations are to burn slash or clear trails through it for deer, to cease disproportionate harvest of high-volume old-growth timber, and to avoid harvesting old-growth stands with exceptional fish and wildlife values.

Mountain goat. The activities of clearing and tree harvest and human disturbance were responsible for the documented direct impact of harassment. The activities of grading/plowing (road construction) and transporting personnel/equipment/material by land were responsible for the documented direct impacts of barriers to movement, harassment, and change in harvest level. Logging, logging camps and associated human noise, and vehicle traffic disturb goat behavior and cause abandonment of preferred high-quality summer range within and near the disturbances. The effects from logging camps have been documented within a 2 km (1.25 mi) radius and include increased mortality of goats. Construction of new roads has blocked goat movement and led to overharvest of previously less accessable populations. No recommendations based on documented impacts were made.

Moose. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. Although the high amount of forage in recent clear-cuts is beneficial to moose in areas of Southeast Alaska where riparian foreage is not abundant, as clear-cuts become dominated by young conifers moose cease using them. During periods of deep snow, moose do not use even recent clear-cuts but feed in high-volume old-growth and river terrace forests and in riparian shrub stands. Mitigation recommendations are to retain forests around and within high-density feeding, breeding, and movement areas, and to retain any old growth river terrace forests or any other old-growth forest types that are limited in extent in the area of concern, as well as a portion of old-growth forests even if they are not limited in extent.

Furbearers. The activity of clearing and tree harvest was responsible for the documented indirect impacts of vegetation composition change to a less preferred successional stage and vegetation damage or destruction due to mechanical removal. No impacts on wolves were documented, only on an important prey species included in the AHMG, Sitka black-tailed deer (q.v.). Populations of marten decline when mature coniferous forests are clear-cut, due to greatly decreased populations of red-backed voles, an important prey species, and due to loss of den sites in hollow trees and deadfalls. In winter, marten do not hunt in clear-cuts but only in dense, mature coniferous forest stands. They will cross but will not hunt in openings greater than 91 m (300 ft) in width. No mitigation recommendations were made for marten. Mink made almost no use of clear-cuts. Mitigation recommendations are to retain windfirm shoreline buffer strips at least 60 m (197 ft) inland from the shoreline. If shoreline forests must be clear-cut, keep the length of shoreline cut as short as possible, never more than 0.8 km (0.5 mi), and avoid cutting shoreline timber on points and in other areas where narrow timber stands separate shorelines, along intertidal zones where the distance between the 0 and +6 m (+20 ft) lines are less than 40 m (131 ft) apart, and along intertidal areas with high exposure of bedrock and boulder cover. Land otters avoid using clear-cuts for travel, burrows, or natal dens. Mitigation recommendations are to avoid logging adjacent to watercourses from early May to late summer (the breeding season) and to retain a windfirm fringe of forest 50 to 75 m (164 to 246 ft) wide along the beach to meet otter habitat requirements. Denning and feeding areas for red squirrels are eliminated by clear-cutting. Red squirrels cannot utilize clear-cuts until cone production by revegetating conifers is reestablished after 20 to 40 yr.

Brown bear. References reviewed for impacts to brown bear included studies conducted in coastal forests and studies conducted in interior forests (e.g., Montana). The activity of clearing and tree harvest produced documented impacts of changes in vegetation composition to less preferred successional stages (e.g., changing old growth to even aged forest), vegetation damage and destruction due to mechanical removal, barriers to movements (e.g., extensive areas of slash), and harassment. The activity of grading (road building) produced a documented direct impact of harassment.

The activity of solid waste disposal produced a documented direct impact of attraction to an artificial food source (i.e., garbage). The activity of human disturbance produced documented direct impacts of harassment and an increase in the harvest of bears (nuisance kills and increased access for hunters).

Bald Eagle. The activity of clearing and tree harvest produced a documented indirect impact of vegetation damage/destruction due to mechanical removal. Logging within 45 m (150 ft) of nest trees resulted in blowdown of nest trees at a rate 20 times more common than when logging occurred further than 45 m (150 ft) from the nest trees.

Activity: clearing and tree harvest.

Impact: vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Skagen, S.K. 1980. Behavioral responses of wintering Bald Eagles on the Skagit River, Washington. Pages 231-241 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, eds. Proceedings of the Washington Bald Eagle symposium. Seattle, WA (ADF&G-F)

Behavioral responses of Bald Eagles to human activity on the Skagit River, northwestern Washington, were observed in this field study conducted during the winters of 1978-1979 and 1979-1980. Habitat adjacent to the Skagit River contains either coniferous or mixed coniferous-deciduous forest, similar to that found along some Alaskan rivers frequented by eagles. The activities of human disturbance and transport of personnel/equipment/material by land produced a documented direct impact of passive harassment. Conclusive results showed that eagles were more sensitive to harassment while feeding on gravel bars than while perching in trees and to approaches by unconcealed humans on foot than by humans in vehicles. A significant decrease in the proportion of eagles feeding or standing on gravel bars was observed when human activity was present within 200 m (650 ft) of the feeding area in the previous 30 minutes. Eagles appeared more tolerant of human activity during periods of low food availability.

Activity: human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Snow, C. 1973. Southern Bald Eagle (Haliaeetus leucocephalus leucocephalus) and northern Bald Eagle (Haliaeetus leucocephalus alaskanus). BLM, Tech. Rept. T-N-171. Denver, CO. 58 pp. #

This paper presents a literature review and summary of knowledge concerning Bald Eagles. A number of impacts are cited. He cites three studies where mortality was found to be largely caused by shooting and considers them the most important of human-caused mortality. One study examined 76 carcasses; 45 (62%) had been shot, 2 died in traps, and 1 was electrocuted. The second study examined 163 carcasses; 91 (55%) had been shot. The third examined 69 carcasses, 28 (40%) of which had been shot.

Electrocution is another source of mortality, but insufficient data are available to determine its impact. Power poles often provide the only available perches in treeless country and are frequently used. Modification of existing lines and appropriate design of new lines would minimize this problem.

Another impact occurs from the use of poison for predator or rodent control, often associated with agriculture or livestock raising.

Pesticides associated with agriculture are another source of mortality. Of 69 Bald Eagles examined for organo-chlorine residues, 6 had lethal levels of dieldrin, 2 others had dieldrin levels high enough to contribute to their deaths, and 1 had died from DDT poisoning.

Widespread use of mercury compounds, primarily used on fungicides in agriculture, has resulted in high concentrations in fish and in turn has also resulted in Bald Eagle mortalities.

The degree of human disturbance was found to influence nesting. A negative relationship was found between the degree of disturbance (within a mile of nests) and nesting activity, realized production, and productive activity. Disturbance levels were classed from 1 to 4. Power and telephone lines, remote buildings, trails, and abandoned logging roads, winter roads, existing rice paddies, and developed plantations appeared to be least disturbing to eagles (Class 1). A railroad with a train a day and inactive or seldom-used roads was somewhat more disturbing (Class 2). Active roads, logging conducted in winter when eagles were not present, and a railroad with traffic rates of four trains per day were found to be even more disturbing (Class 3). The most disturbing factors (Class 4) were medium-to-heavy (e.g., seasonal activity around resorts and campsites) active construction of rice paddies, tree planting, and the blasting of potholes. Timber industry activities, especially plantation preparation occurring when eagles are on their nest sites, was found to be especially critical. Hunting and snowmobiling may also have adverse impacts, but the full extent of their impact has not yet been determined. Another study suggested that human disturbance had little impact once eaglets were hatched and growing.

Increasing development of Alaska is expected to increase human disturbances here. Logging in old-growth timber along shorelines may have an especially heavy impact by eliminating potential and actual nest sites. Evidence indicates that fewer nesting pairs occur in heavily logged areas and that no nest trees have been reported in Southeast Alaska in young stands of timber.

Activity: blasting; chemical application; clearing and tree harvest; human disturbance; processing minerals (including gravel); processing oil/gas; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); morbidity or mortality due to ingestion of or contact with petroleum; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree haravest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: chemical application; clearing and tree harvest; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); morbidity or mortality due to ingestion of or contact with petroleum; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Stalmaster, M.V. 1980. Management strategies for wintering Bald Eagles in the Pacific Northwest. Pages 49-67 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, eds. Proceedings of the Washington Bald Eagle symposium. Seattle, Wa. (ADF&G-F)*

This review paper is a compilation and integration of data collected between 1974 and 1980 on wintering Bald Eagles on the Nooksack River, northwest Washington. The purpose of this paper was to propose management recommendations for protecting Bald Eagles while on their wintering grounds (October through March). The area used by eagles was a segment of braided river containing spawning salmon and bordered by riparian vegetation similar to that found in portions of coastal Alaska, consisting of alder, cottonwood, spruce, cedar, and maple and upland forest composed of Douglas fir, cedar, and hemlock. The activities of human disturbance, transporting personnel/equip- ment/material by land and water and clearing and tree harvest produced documented direct impacts of passive and active (experimental) harassment and vegetation damage/destruction due to mechanical removal. Passive and active harassment displaced eagles temporarily to marginal habitat and interrupted feeding and perching activity. Trees used as perching and roosting sites have been harvested for domestic firewood and commercial purposes and during clearing of waterfront properties. Management recommendations included 1) a 50 m (165 ft) streamside buffer zone to protect diurnal perching sites from logging or development, 2) a buffer zone of 75 to 100 m (250 to 330 ft) in width to protect eagles from human disturbance if at least 50 m (165 ft) of this zone contains dense shielding vegetation, 3) a 250 m (820 ft) buffer zone between human disturbance and riverbanks where vegetation is minimal, 4) a 300 m (1,000 ft) buffer zone between human disturbance and eagles when the human disturbance occurs within the river channel, 5) prohibition of permanent developments within buffer zones, and 6) that restrictions on temporary human activity be required to be in effect only during the wintering period of the local eagle population.

Activity: clearing and tree harvest; human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Stalmaster, M.V., and J.R. Newman. 1978. Behavioral responses of wintering Bald Eagles to human activity. J. Wildl. Manage. 42(3):506-513 (UAF)*

The purpose of this field study was to measure the effects of human disturbance on the behavior of wintering Bald Eagles along the Nooksack River in northwest Washington during the autumns and winters of 1974-1975 and 1975-1976. The study area was a segment of a braided river containing spawning salmon and was bordered by riparian vegetation similar to that found in southeast Alaska, consisting of alder, cottonwood, spruce, cedar, and maple and upland forest composed of Douglas fir, cedar, and hemlock. The responses of juvenile, subadult, and adult Bald Eagles to human disturbance were measured during this study. Human disturbance, both experimental and actual, created documented direct impacts of active and passive harassment. Adult eagles, whether in groups of mixed-aged birds or singly, had greater flight distances (the distance to observer before flying) than did juveniles or subadults when approached by humans. Flight distances were reduced when riparian buffer strips were present. Eagles, particularly adults, were found in greater numbers in areas with low levels of human activities. Feeding birds were particularly sensitive to disturbance, with feeding behavior often disrupted by the mere presence of humans. The authors recommended buffer strips of vegetation 75 to 100 m (250 to 330 ft) wide to reduce the disturbance caused by humans at eagle wintering grounds. They also recommended activity restrictions within 250 m (820 ft) of river channels.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Steenhof, K. 1978. Management of wintering Bald Eagles. USFWS, Biological Services Program. FWS/OSB-78/79. 59 pp. (UAF)*

This paper provides a review of literature describing wintering Bald Eagle behavior, movements, food habits, perching and roosting requirements, and human disturbance to eagles as background information for management guidelines specific to habitat management for wintering Bald Eagles. References reviewed were dated from 1927 to 1976, with the vast majority written in the 1960's and 1970's. Studies reviewed were conducted throughout the United States, although the majority reviewed were conducted in the central United States and the Pacific Northwest. Habitat types were not described for the individual studies. Human disturbance was the only activity reviewed to any extent in this paper, although transport of personnel/equipment/material by land and water were briefly mentioned. Electrocution and powerline impact injuries were casually mentioned as an impact to eagles. Passive harassment was the documented impact described in this paper. The presence of humans and the operation of boats and snowmachines were responsible for the listed impacts. Management guidelines are proposed for protecting wintering Bald Eagle food supplies, perches, and roost sites, and for minimizing electrocution hazards of powerlines and disturbance by humans.

Activity: human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

Thelander, C.G. 1973. Bald Eagle reproduction in California, 1972-1973. Calif. Dept. Fish and Game. Wildl. Manage. Branch, Admin. Rept. No. 73-5. 17 pp.#

During 1973, 31 nesting territories of the Bald Eagle were studied in California. Nineteen pairs were present, and 24 young were produced. However, of 25 territories observed in both 1972 and 1973, there was a reduction of seven active sites in 1973. Data support the conclusion that human disturbance, mainly recreational activity and logging operations at nesting sites and foraging areas, is one major cause of territorial abandonment. Based on an evaluation of human disturbance present at each site, it is estimated that six of the sites active in 1973 are in immediate danger of abandonment. The possibility that abandoned territories will be reoccupied was considered poor under existing conditions. Management recommendations are described.

Activity: clearing and tree harvest; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

U.S. Army Corps of Engineers. 1979. The northern Bald Eagle: a literature survey. #

This paper presents what is probably the best and most current literature survey on the Bald Eagle today. A large section of it covers human-related factors affecting Bald Eagle populations. Four factors appear to have had the largest impact:

1. An increase in human disturbance due to the larger population, greater amounts of leisure time, and the growing popularity of outdoor recreation.

   Researchers generally agree now that human activities in the vicinity of Bald Eagle nesting sites have a negative impact on populations. The degree of disturbance is related to the severity of the impact. The most disturbing factors (within a mile) were tied to heavy recreational use and active and well-used transportation corridors, active construction, and blasting. Timber industry activity, particularly plantation preparation while eagles were on their nests, is considered especially critical. Disturbances during egg laying, incubation, and when the eaglets are small appear to be most detrimental. Human activities on rivers and river bars where eagles feed were also highly disruptive.

2. Loss of nesting habitat through the human activities of timber harvest and land development.

   Bald Eagles prefer to nest and winter near water, but humans also prefer shorelines. Extensive river, lake, and coastal areas in the United States have also been altered by construction of housing developments and big industrial complexes requiring larger quantities of water. Timber harvesting activities have modified vast expanses of land. Unless shoreline fringes are left, eagles are forced from the area for lack of suitable habitat. Large mature trees are preferred by the timber industry as well as by nesting Bald Eagles. In Southeast Alaska, no Bald Eagle nests have been found in second-growth timber. Where timber fringes are left, nest trees are extremely vulnerable to windthrow or damage. Logging practices, especially where clearcutting is involved, increase siltation in nearby waterways and may adversely impact fish upon which Bald Eagles are dependent for food. Lowering the prey base can cause eagles not to breed.

3. Illegal shooting, poisoning, and electrocution.

   Illegal shooting has been the most common cause of Bald Eagle mortality throughout this century. The main reason for this has been the eagles' supposed direct competition with man's economic interests, and sport hunting is another reason.

Predator control by livestock growers has also resulted in accidental Bald Eagle mortalities. Ingestion of lead shot in hunter-killed or crippled waterfowl and rabbits has resulted in a number of documented cases of lethal lead poisoning of eagles.

4. Adverse effects of environmental pollutants.

Bald Eagles, as top carnivores in food chains, tend through the process of biological magnification to receive concentrated doses of many environmental pollutants through their food. The presence of pesticides, PCBs, and heavy metals in Bald Eagles from Alaska to Canada as well as throughout the contiguous lower 48 reflects the widespread contamination by these compounds.

All of the 276 eagle carcasses examined by the Pataxant Wildlife Research Center between 1964 and 1974 were found to have been contaminated by pesticides. All contained DDE and most also contained dieldrin, PCBs, and DDD. About 8.3% of the deaths were estimated to have been caused by dieldrin. Mercury compound concentrated in fish from mercury-polluted, waters which is primarily the result of its use as a fungicide, has also resulted in mortalities. Direct mortality from environmental contaminants and the stress it causes by its presence in lower levels is minor, however, compared to the significantly reduced productivity caused by sublethal doses. Bans on the use of DDT (which metabolizes to DDE and DDD) and PCBs are currently in effect.

Activity: blasting; chemical application; clearing and tree harvest; human disturbance; processing minerals (including gravel); processing oil/gas; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); morbidity or mortality due to ingestion of or contact with petroleum; vegetation damage/destruction due to hydraulic or thermal erosion, etc..

USDI. 1976a. Final environmental impact statement. Pages 322-329 and 501-504 in Alaska natural gas transportation system. Washington, D.C. (ARL)#

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

(1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.

(2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.

(3) Muskoxen may have shifted their traditional summer range by 26 km (16 mi) in response to heavy helicopter traffic.

(4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.

(5) Muskoxen and Canada geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

(1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.

(2) Caribou can apparently tolerate winter blasting if they are not hunted.

(3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.

(4) Waterfowl with young avoid drilling rigs within a 4.3 km (2.6 mi) radius.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

White, C.M., and S.K. Sherrod. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor surveys. Raptor Res. 7(3/4):97-104. (ADF&G-F)*

This paper, based on field observations in interior Alaska, the Aleutian Islands, and the North Slope from 1969 to 1973 and from the North Slope in 1964, discusses the merits of using helicopters for aerial surveys of nesting and brooding raptors. Species observed were Bald Eagles, golden eagles, peregrine falcons, gyrfalcons, and rough-legged hawks. Observations were limited to those raptors that were nesting on cliffs or hillsides in open terrain and not with tree-nesting birds. The activity of transporting personnel/equipment/material by air produced documented impacts of active and passive harassment and a potential impact of collision with aircraft. Specific impacts were not assigned to specific species; impacts are assumed to apply to all species described in the paper. Birds suddenly surprised by the appearance of a helicopter from over the top of a cliff usually panic and exhibit frantic escape behavior, which may result in the dumping of the eggs or young from the nest by the panicked adult. A gradual approach to the nest, in full view of the adult, produced the least amount of disturbance to the birds. The most deleterious times for disturbance are just before egg laying, during egg laying, and during incubation, depending on the species, when disturbance may cause desertion, breakage, or dumping of eggs. Disturbance near nests late in the nesting season may also cause premature fledging of young. Bald Eagles have attacked helicopters that were near nests. Bald Eagle egg production and fledging success were comparable between studies using and not using helicopters.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

16. Ducks

Table 1. Impacts Associated With Each Activity - Ducks

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove	?		?			?	?			?									?				?							
Aquatic vegetation, destruction or change	?		?	X		X	?			?		X	?		?			?	X	X	X	?	?		?	?				X
Attraction to artificial food source												X	?									X								
Barriers to movement, physical and behavioral												?																		
Collision with vehicles or structures												X		X													X	X	X	
Entanglement in fishing nets, debris																X														
Entrapment in impoundments or excavations						X													X	X										
Harassment, active or passive	?				?			X				?		X											?		X	X	X	
Harvest, change in level																														
Introduced wild/domestic species, competition												?	?	?								X								
Morbidity/mortality by ingestion of petroleum				X										?				?	X	X		?			X	X			X	
Parasitism/predation, increased susceptibility					?	X				X		X	X	X													?	?	X	X
Prey base, alteration of			?	?		X	?			?								?	?	?	?	?			X	?		?	?	X
Shock waves (increase in hydrostatic pressure)	?																													
Terrain alteration or destruction			?		?	X	?			X		X										?								X
Veg. composition, change to less preferred		X	?	?	X	?	?			?		X	X																	X
Veg. damage/destruction due to air pollution				?	X													?	?	?	?							?	?	
Veg. damage/destruction due to fire/parasitism		X																												
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion					X					?	?	X										?								
Water level or water quality fluctuations			?			?	?			X		X									?									X

X - Documented impact (see text).
? - Potential impact.

16. DUCKS - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on ducks. Each citation refers to an annotation in the following section, Annotated References to Impacts on Ducks. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to ducks are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to ducks were found for the following activities:

Blasting
Channelizing waterways
Dredging
Fencing
Filling (terrestrial)
Log storage/transport
Processing geothermal energy
Processing lumber/kraft/pulp
Stream crossing - fords
Stream crossing - structures

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Burning:

   a. Veg. composition, change to less preferred

      Dwyer 1970

   b. Veg. damage/destruction due to fire/parasitism

      Dwyer 1970
      Fritzell 1975

2. Chemical application:

a. Aquatic vegetation, destruction or change

Tiner 1984

b. Morbidity/mortality by ingestion of petroleum

Dindal 1970
Flickinger 1979
Stout and Cornwell 1976
Vangilder and Peterle 1983
White et al. 1982

3. Clearing and tree harvest:

a. Veg. composition, change to less preferred

Dwernychuck and Boag 1973

b. Veg. damage/destruction due to air pollution

Dwernychuck and Boag 1973

c. Veg. damage/destruction due to erosion

Sopuck et al. 1979

4. Draining:

a. Aquatic vegetation, destruction or change

Haapanen and Waaramaki 1977

b. Entrapment in impoundments or excavations

Kopischke 1964

c. Parasitism/predation, increased susceptibility

Tiner 1984

d. Prey base, alteration of

Tiner 1984

e. Terrain alteration or destruction

Haapanen and Waaramaki 1977
Sopuck et al. 1979

Tiner 1984
Tiner 1984

5. Drilling:

   a. Harassment, active or passive

      Barry and Spencer 1976
      Sopuck et al. 1979
      USDI 1976a

6. Filling and pile-supported structures (aquatic):

   a. Parasitism/predation, increased susceptibility

      Tiner 1984

   b. Terrain alteration or destruction

      Sopuck et al. 1979
      Tiner 1984

   c. Water level or water quality fluctuations

      Troy 1985

7. Grading/plowing:

   a. Aquatic vegetation, destruction or change

      Sopuck et al. 1979

   b. Attraction to artificial food source

      Bellrose et al. 1945
      Flickinger 1979
      Klebesadel and Restad 1981
      Neff 1955
      Sugden 1976
      White et al. 1982

   c. Collision with vehicles or structures

      Higgins 1977

   d. Parasitism/predation, increased susceptibility

Tiner 1984

e. Terrain alteration or destruction

Sopuck et al. 1979
Tiner 1984

f. Veg. composition, change to less preferred

Higgins 1977

g. Veg. damage/destruction due to erosion

Sopuck et al. 1979

h. Water level or water quality fluctuations

Sopuck et al. 1979

8. Grazing:

a. Parasitism/predation, increased susceptibility

Nelson and Hansen 1959

b. Veg. composition, change to less preferred

Dwyer 1970
Higgins 1977

c. Veg. damage/destruction due to grazing

Bue et al. 1952
Dwyer 1970
Gjersing 1975
Kirsch 1969
Mundinger 1976
Sopuck et al. 1979

9. Human disturbance:

a. Collision with vehicles or structures

Sopuck et al. 1979

b. Harassment, active or passive

Choate 1967

Gollop et al. 1974
Gotmark and Ahlund 1984
Johnson 1984
Lehnhausen and Quinlan 1981
Livezey 1980
Mickelson 1975
Sopuck et al. 1979
Strang 1980
Sugden 1976

c. Parasitism/predation, increased susceptibility

Choate 1967
Gotmark and Ahlund 1984
Johnson 1984
Mickelson 1975
Strang 1980

10. Netting:

a. Entanglement in fishing nets, debris

Bartonek 1965
Schorger 1947
Stout and Cornwell 1976

11. Processing minerals (including gravel):

a. Aquatic vegetation, destruction or change

Tiner 1984

b. Entrapment in impoundments or excavations

Choules et al. 1978

c. Morbidity/mortality by ingestion of petroleum

Choules et al. 1978
Stout and Cornwell 1976

12. Processing oil/gas:

a. Aquatic vegetation, destruction or change

Tiner 1984

b. Entrapment in impoundments or excavations

Choules et al. 1978
Flickinger 1981

c. Morbidity/mortality by ingestion of petroleum

Boag and Lewin 1980
Choules et al. 1978
Flickinger 1981
Stout and Cornwell 1976
Szaro et al. 1980
Vangilder and Peterle 1983

13. Sewage disposal:

a. Aquatic vegetation, destruction or change

Tiner 1984

14. Solid waste disposal:

a. Attraction to artificial food source

Neff 1955

b. Introduced wild/domestic species, competition

Rosen and Bischoff 1950

15. Transport of oil/gas/water - land, ice:

a. Morbidity/mortality by ingestion of petroleum

Albers and Gay 1982
Lambert et al. 1982
McEwan 1980
Rattner and Eastin 1981
Szaro et al. 1980
Vangilder and Peterle 1983

b. Prey base, alteration of

Abraham 1975

16. Transport of oil/gas/water - water:

a. Morbidity/mortality by ingestion of petroleum

Albers and Gay 1982
Jones 1979
Lambert et al. 1982
Lemmetyinen 1966
Leppakoski 1973
McEwan 1980
Rattner and Eastin 1981
Stout and Cornwell 1976
Szaro et al. 1980
Vangilder and Peterle 1983

17. Transport of personnel/equipment/material - air:

a. Collision with vehicles or structures

Stout and Cornwell 1976

b. Harassment, active or passive

Campbell 1984
Gollop et al. 1974
Gollop et al. 1974
Johnson 1984
Lehnhausen and Quinlan 1981
Renken et al. 1983
Schweinsburg 1974
Schweinsburg et al. 1974
Sellers 1979
Slaney and Co. 1973
Sopuck et al. 1979
Sugden 1976
USDI 1976a
Ward and Sharp 1974
Woodward-Clyde Consultants 1982
Wright and Fancy 1980

18. Transport of personnel/equipment/material - land, ice:

a. Collision with vehicles or structures

Anderson 1978
Cornwell and Hackbaum 1971
Sargeant 1981
Slaney and Co. 1973
Sopuck et al. 1979
Stout and Cornwell 1976

b. Harassment, active or passive

Slaney and Co. 1973
Sopuck et al. 1979

19. Transport of personnel/equipment/material - water:

a. Collision with vehicles or structures

Dick and Donaldson 1978

b. Harassment, active or passive

Barry and Spencer 1976
Campbell 1984
Korschgen et al. 1985
Mickelson 1975
Sopuck et al. 1979
Wright and Fancy 1980

c. Morbidity/mortality by ingestion of petroleum

Barrett 1979
Handel 1979

d. Parasitism/predation, increased susceptibility

Mickelson 1975

20. Water regulation/withdrawal/irrigation:

a. Aquatic vegetation, destruction or change

Sopuck et al. 1979

b. Parasitism/predation, increased susceptibility

Sopuck et al. 1979
Tiner 1984

c. Prey base, alteration of

Sopuck et al. 1979

d. Terrain alteration or destruction

Nieman and Dirschl 1973
Sopuck et al. 1979

Tiner 1984

e. Veg. composition, change to less preferred

Nieman and Dirschl 1973
Sopuck et al. 1979

f. Water level or water quality fluctuations

Nieman and Dirschl 1973
Sopuck et al. 1979
Tiner 1984

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to ducks were found for the following categories:

Aquatic substrate materials
Barriers to movement, physical and behavioral
Harvest, change in level
Shock waves (increase in hydrostatic pressure)

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Aquatic vegetation, destruction or change:

   a. Chemical application

      Tiner 1984

   b. Draining

      Haapanen and Waaramaki 1977

   c. Grading/plowing

      Sopuck et al. 1979

   d. Processing minerals (including gravel)

      Tiner 1984

   e. Processing oil/gas

      Tiner 1984

   f. Sewage disposal

      Tiner 1984

   g. Water regulation/withdrawal/irrigation

      Sopuck et al. 1979

2. Attraction to artificial food source:

   a. Grading/plowing

Bellrose et al. 1945
Flickinger 1979
Klebesadel and Restad 1981
Neff 1955
Sugden 1976
White et al. 1982

b. Solid waste disposal

Neff 1955

3. Collision with vehicles or structures:

a. Grading/plowing

Higgins 1977

b. Human disturbance

Sopuck et al. 1979

c. Transport of personnel/equipment/material - air

Stout and Cornwell 1976

d. Transport of personnel/equipment/material - land, ice

Anderson 1978
Cornwell and Hackbaum 1971
Sargeant 1981
Slaney and Co. 1973
Sopuck et al. 1979
Stout and Cornwell 1976

e. Transport of personnel/equipment/material - water

Dick and Donaldson 1978

4. Entanglement in fishing nets, debris:

a. Netting

Bartonek 1965
Schorger 1947
Stout and Cornwell 1976

5. Entrapment in impoundments or excavations:

a. Draining

Kopischke 1964

b. Processing minerals (including gravel)

Choules et al. 1978

c. Processing oil/gas

Choules et al. 1978
Flickinger 1981

6. Harassment, active or passive:

a. Drilling

Barry and Spencer 1976
Sopuck et al. 1979
USDI 1976a

b. Human disturbance

Choate 1967
Gollop et al. 1974
Gotmark and Ahlund 1984
Johnson 1984
Lehnhausen and Quinlan 1981
Livezey 1980
Mickelson 1975
Sopuck et al. 1979
Strang 1980
Sugden 1976

c. Transport of personnel/equipment/material - air

Campbell 1984
Gollop et al. 1974
Gollop et al. 1974
Johnson 1984
Lehnhausen and Quinlan 1981
Renken et al. 1983
Schweinsburg 1974
Schweinsburg et al. 1974
Sellers 1979
Slaney and Co. 1973
Sopuck et al. 1979
Sugden 1976
USDI 1976a

Ward and Sharp 1974
Woodward-Clyde Consultants 1982
Wright and Fancy 1980

d. Transport of personnel/equipment/material - land, ice

Slaney and Co. 1973
Sopuck et al. 1979

e. Transport of personnel/equipment/material - water

Barry and Spencer 1976
Campbell 1984
Korschgen et al. 1985
Mickelson 1975
Sopuck et al. 1979
Wright and Fancy 1980

7. Introduced wild/domestic species, competition:

a. Solid waste disposal

Rosen and Bischoff 1950

8. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Dindal 1970
Flickinger 1979
Stout and Cornwell 1976
Vangilder and Peterle 1983
White et al. 1982

b. Processing minerals (including gravel)

Choules et al. 1978
Stout and Cornwell 1976

c. Processing oil/gas

Boag and Lewin 1980
Choules et al. 1978
Flickinger 1981
Stout and Cornwell 1976
Szaro et al. 1980
Vangilder and Peterle 1983

d. Transport of oil/gas/water - land, ice

Albers and Gay 1982
Lambert et al. 1982
McEwan 1980
Rattner and Eastin 1981
Szaro et al. 1980
Vangilder and Peterle 1983

e. Transport of oil/gas/water - water

Albers and Gay 1982
Jones 1979
Lambert et al. 1982
Lemmetyinen 1966
Leppakoski 1973
McEwan 1980
Rattner and Eastin 1981
Stout and Cornwell 1976
Szaro et al. 1980
Vangilder and Peterle 1983

f. Transport of personnel/equipment/material - water

Barrett 1979
Handel 1979

9. Parasitism/predation, increased susceptibility:

a. Draining

Tiner 1984

b. Filling and pile-supported structures (aquatic)

Tiner 1984

c. Grading/plowing

Tiner 1984

d. Grazing

Nelson and Hansen 1959

e. Human disturbance

Choate 1967
Gotmark and Ahlund 1984

Johnson 1984
Mickelson 1975
Strang 1980

f. Transport of personnel/equipment/material - water

Mickelson 1975

g. Water regulation/withdrawal/irrigation

Sopuck et al. 1979
Tiner 1984

10. Prey base, alteration of:

a. Draining

Tiner 1984

b. Transport of oil/gas/water - land, ice

Abraham 1975

c. Water regulation/withdrawal/irrigation

Sopuck et al. 1979

11. Terrain alteration or destruction:

a. Draining

Haapanen and Waaramaki 1977
Sopuck et al. 1979
Tiner 1984
Tiner 1984

b. Filling and pile-supported structures (aquatic)

Sopuck et al. 1979
Tiner 1984

c. Grading/plowing

Sopuck et al. 1979
Tiner 1984

d. Water regulation/withdrawal/irrigation

Nieman and Dirschl 1973
Sopuck et al. 1979
Tiner 1984

12. Veg. composition, change to less preferred:

    a. Burning

        Dwyer 1970

    b. Clearing and tree harvest

        Dwernychuck and Boag 1973

    c. Grading/plowing

        Higgins 1977

    d. Grazing

        Dwyer 1970
        Higgins 1977

    e. Water regulation/withdrawal/irrigation

        Nieman and Dirschl 1973
        Sopuck et al. 1979

13. Veg. damage/destruction due to air pollution:

    a. Clearing and tree harvest

        Dwernychuck and Boag 1973

14. Veg. damage/destruction due to fire/parasitism:

    a. Burning

        Dwyer 1970
        Fritzell 1975

15. Veg. damage/destruction due to grazing:

    a. Grazing

        Bue et al. 1952

Dwyer 1970
Gjersing 1975
Kirsch 1969
Mundinger 1976
Sopuck et al. 1979

16. Veg. damage/destruction due to erosion:

   a. Clearing and tree harvest

      Sopuck et al. 1979

   b. Grading/plowing

      Sopuck et al. 1979

17. Water level or water quality fluctuations:

   a. Filling and pile-supported structures (aquatic)

      Troy 1985

   b. Grading/plowing

      Sopuck et al. 1979

   c. Water regulation/withdrawal/irrigation

      Nieman and Dirschl 1973
      Sopuck et al. 1979
      Tiner 1984

ANNOTATED REFERENCES TO IMPACTS TO DUCKS

The annotated bibliography contains only references that discuss documented impacts to ducks. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to ducks are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Abraham, K.F. 1975. Waterbirds and oil-contaminated ponds at Point Storkersen, Alaska. M.S. Thesis. Iowa State Univ., Ames. 39 pp. (ADF&G-F, Habitat)

This field study was conducted during the spring and summer of 1974 and 1975 near Point Storkersen, approximately 20 km (12 mi) northwest of Prudhoe Bay, and was designed to determine the immediate effects of crude oil contamination on aquatic macroinvertebrates and bird activity in certain wetlands. Habitat within the study area is coastal tundra. Experimental studies were conducted in shallow ponds 10-40 cm (4-16 in) deep that contained emergent sedges. Waterbirds observed during the course of the study included shorebirds (primarily phalaropes), waterfowl (eiders and oldsquaw), and passerines. The activity of transporting oil/gas/water by land produced a documented direct impact of alteration of prey base. The experimental introduction of measured quantities of crude oil to selected ponds caused selective reduction of some invertebrate taxa following light spills (19 l/ha [2 gal/ac]). Spills at higher rates (2,000 l/ha [200 gal/ac]) significantly reduced all sediment surface and swimming invertebrates to very low numbers. Frequency of use by oldsquaw and phalaropes decreased significantly on oiled ponds in both 1974 and 1975. The author suggested that 1) gathering lines not be placed across or near flowing water systems, which could spread spilled oil to other wetlands during flood stages, 2) that plans be made to control all spills, and 3) that residual oil be removed to reduce the incorporation of oil into sediments and to reduce the possibility of birds becoming oil-covered by contact with surface slicks and contaminated vegetation.

Activity: transport of oil/gas/water - land.

Impact: prey base, alteration of.

Albers, P.H., and M.L. Gay. 1982. Effects of a chemical dispersant and crude oil on breeding ducks. Bull. Environ. Contam. Toxicol. 29(4):404-411. (UAF)#

A study was conducted to evaluate the effects of Corexit and crude oil sprayed with Corexit 9527 on breeding mallard ducks. Fifty-four pairs of two-year-old mallard ducks were placed in outdoor pens at the Patuxent Wildlife Research Center, Laurel, Maryland. Four control, five crude oil, five oil-dispersant, and five dispersant nests were monitored for nest and egg temperature. The percentages of hatching success, egg loss, and duckling survival were calculated for each clutch. After termination of the breeding study, a supplemental test to determine the adherence potential of crude oil sprayed with diluted Corexit 9527 was conducted.

Results indicated that the egg hatchability of both the crude oil and oil-dispersant groups was lower than that of the control. The conclusion, therefore, was that a crude oil-Corexit 9527 mixture will probably pose the same threat to eggs of nearby birds as will crude oil alone.

A supplemental test showed that bird oiling can be reduced by dispersing part of the surface oil into the water column.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Anderson, W.L. 1978. Waterfowl collisions with power lines at a coal fired plant. Wildl. Soc. Bull. 5(2):77-83. (ARL)#

In the fall of 1973, the Illinois Natural History Survey initiated a four-year chemical and biological investigation at the Lake Sangchris-Kincaid Power Plant complex in central Illinois.

The study found that between 200 and 400 waterfowl (0.2-0.4% of maximum number present) were killed each fall, 1973-1975, by colliding with high voltage transmission lines that cross the slag pit at the plant and the adjacent lake. Mallards constituted 37% of the victims, blue-winged teal 17%, and American coots 25%. Blue-winged teal were most vulnerable to collisions (0.549 casualties per 1,000 bird-days of use of the slag pit) and mallards least vulnerable (0.026). Factors contributing to the frequency of collisions were 1) the number of waterfowl present, 2) weather conditions and visibility, 3) species composition or behavior of birds, 4) disturbance, and 5) the familiarity of the birds with the area.

Activity: transport personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Barrett, R.T. 1979. Small oil spill kills 10-20,000 seabirds in north Norway. Mar. Pollut. Bull. 10(9):253-255. (UAF)

This paper reports the death of an estimated 10,000-20,000 seabirds and seaducks from an unknown source of light fuel oil off the coast of north Norway between March 23 and 29, 1979. Approximately 90% of the dead birds were Brunnich's guillemots (Uria lomvia), also known as thick-billed murres. Also killed were an estimated 500-1,000 common, king, and steller's eiders, and oldsquaws. These five species also occur commonly in Alaskan waters. A description of habitat within the affected area was not provided. The activity of transporting personnel/equipment/material by water produced the documented direct impact of mortality due to ingestion of or contact with petroleum products.

Activity: transport of personnel/equipment/material - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Barry, T.W., and R. Spencer. 1976. Wildlife response to oil well drilling. Can. Wildl. Serv. Prog. Notes No. 67. Canadian Wildlife Service, Edmonton, Alberta. 15 pp. (HD)*

A field study of the effects of oil-well drilling on wildlife in the vicinity of the Taglu G-33 site in the MacKenzie River delta, Northwest Territories, Canada, was conducted during June, July, and August 1971. Species studied included nesting and molting Canada, white-fronted, and snow geese, whistling (tundra) swans, and dabbling and diving ducks. Habitat within the area is coastal tundra. The activity of drilling produced a documented direct impact of passive harassment. Whistling swans, white-fronted geese, Canada geese, pintails, green-winged teal, and scaup were less abundant in plots within 2.5 km (1.5 mi) of the drill rig than in control plots 8 km (5 mi) distant. Molting flocks or family groups of whistling swans, white-fronted geese, Canada geese, and snow geese moved or stayed more than 2.5 km (1.5 mi) from the drill rig. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment and increased susceptibility to predation. Swans and geese flushed, swam, or ran from a helicopter at distances ranging from 10 m to 2.4 km (30 ft to 1.5 mi), depending on the species and their stage of incubation or molt. Snow geese would flush from their nests from 0.8 to 2.4 km (0.5 to 1.5 mi) ahead of the helicopter and would begin to return to the nest site when the helicopter was 0.8 km (0.5 mi) past the nest site. Resettling on the nests took up to 45 min after passage of the helicopter, because fights occurred as the disturbed birds crossed the territories of others to regain their own nests. Gulls and jaegers preyed on goose eggs more heavily than usual when the disturbed geese were off their nests. The activity of transporting personnel/equipment/material by water produced a documented direct impact of passive harassment. Ducks and swans either flushed or swam as a supply tug and barge approached.

Activity: drilling; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Bartonek, J.C. 1965. Mortality of diving ducks on Lake Winnipegosis through commercial fishing. Can. Field-Nat. 79:15-20. (UAF)

This paper is the result of field observations that appraised the mortality of diving ducks caught in commercial fishing nets or net fragments at Lake Winnipegosis, Manitoba, Canada. Observations of duck mortality were made during the summers of 1961-1963. Species observed caught in gill nets included redhead, canvasback, common goldeneye, common loon, grebes, and one American widgeon. The large shallow lake contained several bays used by ducks for molting and can be considered analogous to habitat used by some ducks within Alaska. The activity of netting produced a documented direct impact of entanglement in nets. Dead ducks were found in lost net fragments and in actively fished nets. Sixty-five of a sample of 76 ducks killed in nets were redheads. Only seven of the ducks killed in the nets were juveniles. Nearly all of the adult ducks were molting at the time of their death. Male ducks were found entangled in nets significantly more often than were females. It was estimated that between 450-900 ducks and 3,000 grebes and loons died annually in nets fished in the southern half of Lake Winnipegosis.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Bellrose, F.C., Jr., H.C. Hanson, and P.D. Beamer. 1945. Aspergillosis in wood ducks. J. Wildl. Manage. 9(4):325-326. (UAF)

This short paper describes the occurrence of aspergillosis in wood ducks observed feeding on spoiled corn in September 1943 in a field near Havana, Illinois. Ages and sexes of the infected birds were not reported. Descriptions of habitat of the area were also not reported. Although neither fields of corn nor wood ducks in any numbers are present in Alaska, the impacts to ducks of the fungus *Aspergillus*, which also can be found on other types of grain, could be expected to be similar to other species of ducks within agricultural areas of Alaska should an outbreak of this disease occur. The activity of grading and plowing produced a documented direct impact of attraction to an artificial food source. Approximately 500 to 1,500 wood ducks were observed feeding on the moldy corn. Eighty-nine wood ducks were found dead and several hundred more appeared to be incapacitated to some degree. Conclusive results indicated the birds had died from aspergillosis. The ducks apparently aquired the disease from breathing air contaminated with the fungal spores that were dispersed while the ducks fed on the moldy corn.

Activity: grading/plowing.

Impact: attraction to artificial food source.

Boag, D.A., and V. Lewin. 1980. Effectiveness of three waterfowl deterrents on natural and polluted ponds. J. Wildl. Manage. 44(1):145-154. (UAF)

This paper reports the results of field research conducted from May through October 1975 and 1976 near Fort McMurray, Alberta that tested the effectiveness of three types of devices in deterring waterfowl from entering a small series of natural ponds and a tailings pond from an oil sands extraction plant. Species of ducks observed at the natural ponds included lesser scaup, redhead, ringed-neck duck, mallard, blue- and green-winged teal, widgeon, bufflehead, and pintail. Ages or sexes of ducks observed were not reported. Both the natural and the tailings ponds were within the boreal forest zone. The activity of processing oil/gas produced a direct documented impact of morbidity and mortality due to ingestion of or contact with petroleum or petroleum products. Six geese of unspecified species, 42 dabbling ducks, and 65 diving ducks (mostly _Aythya_ spp. - lesser scaup, ring-necked duck) were found dead or moribund in the 150-ha (375-acre) tailings pond that contained both aqueous and bituminous effluent from an oil sands extraction plant. Data suggested that waterfowl were more vulnerable to bitumen fouling during spring migration. Of the three deterrents (a model falcon, a moving series of reflectors suspended from a frame, and a human effigy) tested at the natural ponds, only the human effigy appeared to be effective; diving ducks of the genus _Aythya_ were affected most. The placement of 27 human effigies on the tailings pond was considered effective in reducing the number of waterfowl deaths at the pond during 1976 when compared with the number of birds found at the site when no effigies were present. Most of the waterfowl were suspected to have entered the tailings pond at night, at a time when the visibility of the effigies was minimal. The authors suggested that some means of increasing visibility of the deterrents at night might increase their effectiveness.

Activity: processing oil/gas.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Bue, I.G., L. Blankenship, and W.H. Marshall. 1952. The relationship of grazing practices to waterfowl breeding populations and production on stock ponds in western South Dakota. Trans. N. Am. Wildl. Conf. 17:396-414. (GD)#

A two-year study (1950-1951) was made in Stanley County, South Dakota, to determine waterfowl use and production on stock ponds and to determine the relationship of land-use practices to waterfowl use and production on individual ponds. Waterfowl species breeding in this area were blue-winged teal, mallard, pintail, shoveller, gadwall and baldpate.

A nesting study showed that 19 of 20 nests were found in areas that had been grazed no more than 14.9 cattle-days per acre-year. Green needlegrass and western wheatgrass or a combination of the two species made up the preferred nesting cover.

Shoreline cover was influenced by grazing intensity. Grass type shorelines could be expected when the grazing intensity was under 15 cattle-days per acre-year whereas mud shorelines could be expected with grazing intensities of 30 or more cattle-days per acre-year. Grass type shorelines supported two to three times as many pairs of breeding waterfowl and were utilized by broods three to four times as much as those ponds with mud shorelines.

Activity: grazing.

Impact: vegetation damage/destruction due to grazing by domestic or introduced animals.

Campbell, B.H. 1984. Fall activity of airboats and aircraft on Coffee Point, Palmer Hay Flats and their impacts on waterfowl and hunting. Draft rept. ADF&G, Anchorage. 26 pp. (ADF&G, F-Habitat)

This report summarizes the results of a study conducted by ADF&G during the fall of 1983 that examined the current public attitude on airboat and aircraft use on the Palmer Hay Flats State Game Refuge, quantified the hunting effort at Coffee Point, and documented the amount of aircraft and airboat traffic on the Hay Flats and the reaction of waterfowl to this traffic. A combination of field observations, hunter interviews, and mail questionaires were used to gather data. Observations were made of both ducks and geese during September and October (species-specific observations were not provided). Habitat within the area of study includes river delta, tidal mud flats, small creeks, sloughs, and wetlands. The activities of transporting personnel/equipment/material by air and water produced a documented direct impact of harassment. The reactions of 550 ducks and 2,931 geese to aircraft overflights were recorded. Fifty-five percent of the ducks and all of the geese flushed when overflown by aircraft at altitudes less than 152 m (500 ft) and at distances within 400 m (¼ mi) of the birds. No ducks were flushed by aircraft flying above 152 m (500 ft) and within 400 m (¼ mi) of the birds; 16% of the geese observed flushed under the same conditions of disturbance. Approximately 70% of the ducks and 43% of the geese milled about and returned to the area from which they were flushed; the remainder flew to other locations. Reactions of ducks to aircraft overflights became more severe as fall progressed. Waterfowl resting and feeding along sloughs typically allowed airboats to approach closer before flushing than did birds on ponds, likely the result of limited visibility resulting from meanders in the slough and high slough banks. Resident ducks did not flush until the airboat was on average 69 m (225 ft) away, and resident geese did not flush until the airboat was on average 115 m (375 ft) away. About 52% (25 ducks) of the ducks flushed from sloughs returned after the airboat passed; none of the 63 geese returned. Ducks setting on ponds flushed an average of 197 m (645 ft) from airboats, and nearly 67% returned after the airboat passed. Migrating ducks appeared to be more sensitive to disturbance by airboats than were resident ducks. In October, ducks flushed an average of 400 m (¼ mi) from airboats as compared with an average flushing distance of 137 m (450 ft) (mean of combined values for ducks on ponds and sloughs) in September. All ducks flushed by airboats after October 1 left the area.

[Reviewer's note: Conclusions about the effects of airboats and aircraft should be considered tentative because of the low sample sizes for waterfowl, aircraft, and airboats.]

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Choate, J.S. 1967. Factors influencing nesting success of eiders in Penobscot Bay, Maine. J. Wildl. Manage. 31(4):769-777. (UAF)

This field study, conducted during the spring and summer of 1964 and 1965 in Penobscot Bay, Maine, examined several factors, including human disturbance, that were believed to influence the breeding success of common eiders. Eider nests were studied on five small vegetated islands in Penobscot Bay. The nesting habitat used by eiders in this study is structurally similar to that used by nesting eiders in portions of Alaska. The activity of human disturbance produced documented direct impacts of harassment and increased susceptibility to predation. Human visitation of eider nests caused female eiders to flush from their nests. Gulls frequently preyed on eider eggs before the eiders returned to their nests. A few clutches were apparently lost because of overexposure to heat when females were flushed from their nests on hot days. Nesting success of eiders was significantly lower on one island that had twice the number of human visits than on a comparable nearby island.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Choules, G.L., W.C. Russell, and D.A. Gauthier. 1978. Duck mortality from detergent-polluted water. J. Wildl. Manage. 42(2):410-414. (UAF)

This paper reports the results of laboratory investigations conducted during fall 1974 to determine the cause of recurring waterfowl die-offs on a 36-ha (90-acre) industrial waste basin located at Denver, Colorado. Yearling male mallards were used in the laboratory experiments. Species of waterfowl that died within the waste basin were not reported. Habitat descriptions for the area surrounding the waste basin were not provided. The use of uncovered waste basins by a variety of development activities (e.g., oil drilling, mining) within Alaska makes this study applicable to Alaskan situations. The activities of processing oil/gas and minerals produced documented direct impacts of morbidity and mortality due to contact with petroleum, petroleum products, and chemicals, and entrapment in impoundments. Conclusive results showed that a detergent-water mixture containing the same concentration of detergent as the polluted waste water similarly wet the feathers and rapidly chilled the ducks even though no other pollutants were present. Swimming ducks were observed to become increasingly wetted, until two-thirds to three-fourths of their bodies were submerged. Survival time of ducks roughly doubled with each 10°C rise in water temperature (to 40°C). Insecticides present at the waste basin were of concentrations insufficient to cause the rapid death observed of ducks at the basin. Dead or dying ducks collected from the waste basin had measurable quantities of pesticides and mercury in their tissues but at levels far below lethal concentrations.

Activity: processing minerals (including gravel); processing oil/gas.

Impact: entrapment in impoundments or excavations; morbidity or mortality due to ingestion of or contact with petroleum.

Cornwell, G., and H.A. Hackbaum. 1971. Collisions with wires - a source of anatid mortality. Wilson Bull. 83(3):305-306. (ARL)#

Observations on northern prairie breeding grounds suggest that duck collisions with overhead wires are common, though generally unnoticed and unreported. Transmission lines can become a frequent source of duck mortality. The authors suggest that alternatives to running overhead lines through marshes be considered.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Dick, M.H., and W. Donaldson. 1978. Fishing vessel endangered by crested auklet landings. Condor 80(2):235-236. (UAF)

This short paper reports several instances where seabirds collided with and/or landed on fishing and fish-processing vessels during nighttime hours in Kodiak or Aleutian islands waters. Seabirds species that collided with vessels and died were crested and whiskered auklets and, in one instance, king eiders. Strong winds and rough seas during winter months (November-April) were usually associated with the incidents. The activity of transporting personnel/equipment/material by water produced a documented direct impact of collision with vehicles. In one instance, an estimated 6,000 crested auklets landed on an 86-ft-long vessel, apparently attracted to the vessel's running lights. A minimum of 15 dead birds were found on the vessel; the remaining live birds were tossed over the side of the vessel. In another instance, approximately 1,100 dead whiskered auklets were found on a 230-ft fish-processing vessel after a storm. The birds were apparently attracted to the ship's processing lights, which were on continuously during the night. The authors proposed that offshore oil and gas development, with platform lights, flaring gasses, or both, could pose new threats to seabirds that are attracted to lights.

Activity: transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Dindal, D.L. 1970. Accumulation and excretion of Cl^{36} DDT in mallard and lesser scaup ducks. J. Wildl. Manage. 34(1):74-92. (GD)#

The ingestion, metabolism, storage, and excretion of radio-labeled chlorine-36 DDT in wild mallard ducks (Anas platyrhynchos) and lesser scaup ducks (Aythya affinis) was investigated during 1964 and 1965. A single application of isotope-labeled pesticide was made to a four-acre marsh at the rate of 0.2 lb/A in 1964. A total of 112 ducks was subsequently introduced to the treated unit and collected after various exposure periods. Twenty-one tissues and organs from each duck were assayed for DDT residues, using liquid scintillation spectrometry, electron capture gas-liquid chromatography, and thin-layer chromatography. A total of 3,760 experimental tissue samples from the 112 ducks and 850 background samples from 29 ducks were processed. Residues of DDT were found at some time in all tissues tested except the testes of lesser scaup. Lesser scaup thyroids, spleen, testes, and ovaries contained no detectable residues during the second year. The compounds DDE, DDD, and p, p'-DDT were most common, but DDE was the predominant metabolite found throughout the two-year period. DDMU was recovered from the liver and brain of both species. Metabolite concentrations are given for tissues sampled. Definite relationships exist between the type of food ingested (plant or animal) and DDT residues. This is reflected in the higher residue levels in scaup tissues. Some of the highest residue concentrations were found in leg fat (mallard 32.8 ppm; scaup 67.2 ppm) and neck fat (mallard 43.8 ppm), and in the uropygial gland (mallard 34.7 ppm; scaup 36.8 ppm), and adrenal glands (mallard 14.8 ppm; scaup 18.3 ppm). The dynamics of equilibrium storage and excretion of DDT residues were also observed.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Dwernychuck, L.W., and D.A. Boag. 1973. Effects of herbicide induced changes in vegetation on nesting ducks. Can. Field-Nat. 87(2):155-165. (GD)#

Over a three-year period, the effect of changes in characteristics of vegetation, induced by the herbicide, 2,4-D ester, on numbers and distribution of duck nests located on two islands in a lake in Alberta was studied. Application of the herbicide significantly reduced the areas dominated by broad-leaved plants and permitted the expansion of areas dominated by grasses. Ducks preferred to nest among broad-leaved plants but avoided nesting among grasses. The distribution of duck nests was aggregated with concentrations of nests in areas of preferred cover that had remained unsprayed. Numbers of nesting ducks declined over the period of study, probably due to the decline in availability of plants preferred for nest sites.

Activity: clearing and tree harvest.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to air pollution or contact with petroleum products.

Dwyer, T.J. 1970. Waterfowl breeding habitat in agricultural and non-agricultural land in Manitoba. J. Wildl. Manage. 34(1):130-136. (GD)#

The objectives of this paper were 1) to contrast waterfowl use and production on agricultural and nonagricultural land in the aspen parkland of Manitoba, and 2) to assess some characteristics of pothole habitat for waterfowl production in the two areas. This study was based on intensive field work carried out from April 23 to August 31, 1968.

The study found that agricultural land potholes lacking in or incompletely surrounded by trees received greater use by lesser scaup, canvasback, redhead, coot, and three species of grebes. The nonagricultural land potholes completely surrounded by trees were more attractive to blue-winged teal and mallard, and over twice as many dabbler broods were censused there. Abundant, undisturbed nesting cover may have been the reason for greater dabbler use on the nonagricultural land potholes. Cultivation and heavy grazing around potholes in the agricultural land restricts nesting to limited areas. Widespread spring burning also eliminates much nesting cover.

The significance of this study lies in the higher habitat occupancy by waterfowl of a nonuse area as compared with an intensively farmed area only a short distance away. This occurred even though the nonuse area was forested habitat, not generally thought to be prime duck habitat.

Activity: burning; grazing.

Impact: vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to fire or induced parasitism; vegetation damage/destruction due to grazing by domestic or introduced animals.

Flickinger, E.L. 1979. Effects of aldrin exposure on snow geese in Texas rice fields. J. Wildl. Manage. 43(1):94-101. (UAF)

This paper reports the results of field observations and laboratory analysis of moribund or dead snow geese that were found in or near fields that had been seeded with aldrin-treated rice. The study area was located in southern Texas and contained largely rice fields and pastures, interspersed with woodlands, two large reservoirs, and numerous small ponds. Detailed investigations of goose mortality were undertaken during March and April 1972-1976. Although rice is not grown in Alaska, other cereal crops are grown that if treated with toxic pesticides could cause similar impacts to geese. The activities of grading and plowing and chemical application produced documented direct impacts of attraction to an artificial food source and morbidity and mortality due to ingestion of chemicals. Snow geese and some white-fronted and Canada geese were attracted to pastures and rice-stubble fields. Newly planted rice fields that were recently flooded also attracted geese and served as the source of the pesticide that cause debilitation or death of geese. Conclusive results indicated that 52 and 60 snow geese, mostly immature white-phase males, were found dying or dead in 1972 and 1974, respectively. Observations of behavior of dying geese and chemical analyses of tissue samples from dead geese indicated the presence of debilitating and lethal concentrations of dieldrin (a metabolite of aldrin). No deaths were observed in 1973 or 1976, when geese left the area before planting of rice occurred. The use of aldrin was also discontinued in 1975. Small numbers of Canada and white-fronted geese died from aldrin poisoning, as did two blue-winged teal. Evidence suggested that geese were adversely affected during spring migration and possibly during nesting. Single moribund geese displaying symptoms of dieldrin poisoning were frequently observed some distance from rice fields. Dieldrin residues were found in the brains of 4 of 5 unsuccessful nesting female snow geese found dead at McConnell River (a nesting colony in Canada used by geese that winter in Texas rice fields) in 1972 and 4 of 5 females from failed nests, whereas only 1 of 10 successful nesters contained such residues.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Flickinger, E.L. 1981. Wildlife mortality at petroleum pits in Texas. J. Wildl. Manage. 45(2):560-564. (GD)#

This study reports wildlife mortality at inland petroleum pits in six southeastern Texas counties.

The heaviest mortality observed occurred at insufficiently covered styrene tar pits at a petrochemical factory after the tar had seeped through the landfill to the surface of the pits. When animals came in contact with the pools of tar they become trapped in the sticky substance and were held there until they died. Most of the dead animals were birds.

Wildlife mortality, particularly of birds, at oil sludge pits appears to be widespread. Dead birds were found in 30% of the open pits; many birds sink into the oil and tar, so mortality figures are probably low. In general, the mortality of ducks was greatest in large, open, oil sludge waste disposal pits.

Activity: processing oil/gas.

Impact: entrapment in impoundments or excavations; morbidity or mortality due to ingestion of or contact with petroleum.

Fritzell, E.K. 1975. Effects of agricultural burning on nesting waterfowl. Can. Field-Nat. 89(1):21-27. (GD)#

The study was conducted during the spring and summer of 1970 and 1971 in a 10.4 km^2 (4 mi^2) area south of Minnedosa, Manitoba.

Agricultural burning in an intensively farmed region within Manitoba's pothole district is shown to affect the nesting activities of ground nesting ducks. During the study, most burning occurred after the peak of first nest initiation by mallards and pintails and before most blue winged teal nesting activity. It appears that early nesting ducks are more susceptible to destruction of nests by fire than later-nesting species.

All species, except blue winged teal, preferred unburned nest cover, although success was higher in burned areas, where predators may have exerted less influence.

Activity: burning.

Impact: vegetation damage/destruction due to fire or induced parasitism.

Gjersing, F.M. 1975. Waterfowl production in relation to rest rotation grazing. J. Range Manage. 28(1):37-42. (GD)#

Duck production was compared in two rest rotation cattle-grazing systems and normally grazed areas in Phillips County, Montana, from 1968 to 1970. Pair populations generally increased in pastures excluded from cattle grazing the previous year and decreased in pastures grazed in the fall of the previous year. In 11 of 12 instances, complete rest or grazing only during spring and early summer, resulted in an increase of the number of broods the following spring. In five of eight instances, grazing during summer and fall resulted in a decrease of broods the following spring.

Activity: grazing.

Impact: vegetation damage/destruction due to grazing by domestic or introduced animals.

Gollop, M.A., J.R. Goldsberry, and R.A. Davis. 1974. Aircraft disturbance to moulting sea ducks, Herschel Island, Yukon Territory, August 1972. Pages 202-231 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 5. (UAF)

This field study was conducted on the sheltered waters of the south side of Herschel Island, Yukon Territory, Canada, during August 1972. The objectives were to determine if aircraft disturbance affects the normal behavior of molting sea ducks, to determine the disturbance effects on the ducks of aircraft flying at various altitudes, and to determine whether intensive aircraft activity would drive the sea ducks from the sheltered areas. The species of primary concern in this study were oldsquaw and surf scoters. Small numbers of scaup, white-winged scoter, red-breasted mergansers, and four species of loons were also present but probably used the area as a feeding ground rather than as a molting area. Sex and age data for the observed ducks were not presented. Herschel Island is located approximately 3-5 km (2-3 mi) offshore of the mainland and has a series of islands and spits that shelter the southern shoreline, the site of this study. The physiography of this area is similar to that found in other coastal regions of Alaska. The activity of transporting personnel/equipment/material by air produced a documented direct impact of active harassment. Hourly flights by a helicopter at varying altitudes and distances caused up to 1,400 molting waterfowl to alter patterns of normal behavior. Ducks moved off the land into the water as early as the first pass by the helicopter at an altitude of 228 m (750 ft). The birds were aware of the approach of the helicopter when it was at a distance of 0.8 to 1.6 km (½ to 1 mi). Flock sizes increased as disturbance continued. Surf scoters appeared to be more sensitive than oldsquaws to the disturbances. Oldsquaws rested and slept (on water) more on disturbance days; surf scoters rested less and swam and fed more.

[Reviewer's note: This entire study was conducted during a 3-d period; an initial day of baseline observations followed by a day of experimental disturbance plus another day of disturbance 8 d later. Caution should be used when considering the results of the study, particularly in light of the 1-d's baseline behavioral data collected for these birds.]

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gollop, M.A., J.E. Black, B.E. Felske, and R.A. Davis. 1974. Disturbance studies of breeding black brant, common eiders, glaucous gulls, and arctic terns at Nunaluk Spit and Phillips Bay, Yukon Territory, July, 1972. Pages 153-201 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 4. (UAF)*

The purpose of this field study, conducted in June and July 1972 at Nunaluk Spit and Phillips Bay, Yukon Territory, Canada, was to determine the effects of helicopters and fixed-wing aircraft and human disturbance on the reproductive success and behavior of breeding black brant, common eiders, glaucous gulls, and arctic terns. The habitat used by breeding and nonbreeding birds was a sparsely vegetated offshore barrier island formation associated with the Firth and Malcolm river deltas, similar to barrier island formations found along coastal Alaska. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment for black brant, glaucous gulls, and arctic terns. The activity of human disturbance produced documented direct impacts of active and passive harassment for all species studies. Conclusive results showed that helicopters produced a greater reaction from incubating birds than did fixed-wing aircraft, except for incubating common eiders, which showed no obvious response to either type of aircraft. Incubating gulls were the most sensitive to human disturbance, with eiders the least sensitive. The responses of arctic terns to human disturbance were not recorded. Nonincubating birds showed greater intolerance to disturbance than did incubating birds. Recommendations included 1) that helicopters stay above 460 m (1,500 ft) when flying over colonies of nesting common eiders, black brant, glaucous gulls, and arctic terns; 2) that fixed-wing aircraft stay above 150 m (500 ft) when flying over such colonies; 3) that flights over colonies at any altitude during the breeding season be kept at an absolute minimum to reduce the possibility of lowering tolerance levels through repeated exposure to passive or active harassment; and 4) that under no circumstances should any person be allowed to visit islands during the period in which they are being used by nesting sea birds.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gotmark, F., and M. Ahlund. 1984. Do field observers attract nest predators and influence nesting success of common eiders? J. Wildl. Manage. 48(2): 381-387. (UAF)*

This field study was conducted from April to June 1981 on grass- and shrub-covered islands in southern Sweden in an attempt to test whether avian predators were attracted to nests where observers flushed incubating common eiders. The study area is similar in latitude to portions of Alaska. The activity of human disturbance produced documented direct impacts of increased susceptibility to predation, and active harassment. Conclusive results showed that increased predation of eggs by gulls occurred after eiders were flushed from their nests by humans. This increase was not statistically significant, however. The distances at which humans flushed eiders from their nests were not presented. Predation of eggs in simulated eider nests showed that eggs in nests covered with down were less likely to be robbed by avian predators than eggs in uncovered nests. The authors recommended that nests from which females are flushed be covered with down.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Haapanen, A., and T. Waaramaki. 1977. Changes in the use of wetlands in two drainage basins and the effects e.g. on waterfowl populations. Finnish Game Research 36:19-48. (ADF&G-F, Habitat)

This paper examines the land use changes in two drainage basins in southwest Finland from 1883 to 1972, based on review of historical maps and records, more recent field work, and aerial photographs. Habitat within the study area consisted of a combination of woodlands, cultivated fields, wetlands, peatlands, and lakes. Although habitat used in Finland by waterfowl may be structurally different than that in Alaska, it is functually similar in its use by waterfowl for nesting and feeding. Species of ducks reported to use the wetlands of the study area include mallard, green-winged teal, pintail, shoveler, European widgeon, and common goldeneye. The activity of draining produced documented direct impacts of terrain alteration and destruction and destruction of aquatic vegetation. Forty percent of the lakes and ponds present in 1883 were completely drained by 1972, with a decrease in the total water area by 50%. In 1972, the shoreline was only 64% of its 1883 length. Wetlands were drained primarily for agricultural and forestry purposes. Several lakes that were drained contained soils too acid for farming or forestry. Several lakes that had supported breeding waterfowl populations were completely drained during this period. It is estimated that the waterfowl capacity of the lakes in the study area in 1972 was only 55% of what it was in the 1880's.

Activity: draining.

Impact: aquatic vegetation, destruction or change in composition; terrain alteration or destruction (e.g., raptor cliffs).

Handel, C.M. 1979. Preliminary assessment of impacts to bird resources from the grounding of the F/V Ryuyo Maru No. 2 on St. Paul Island, Alaska. Unpubl. Mss. USFWS, Anchorage, AK. 17 pp. (ADF&G-F, Habitat)

This report summarizes the results of a field reconnaissance conducted 14-16 November 1979 to assess the immediate and predicted impacts to birds from the 8 November 1979 grounding of the 300-ft Japanese fishing vessel Ryuyo Maru No. 2 on St. Paul Island, Alaska. The activity of transporting personnel/equipment/material by water produced a documented direct impact of morbidity and mortality due to ingestion of or contact with petroleum. Eight days after the grounding, an estimated 100,000 gallons of diesel oil had leaked from the vessel, polluting nearshore waters immediately adjacent to seabird nesting cliffs and the only saltwater lagoon on the island. Dead birds found oiled on St. Paul Island included 33 glaucous-winged gulls, 11 harlequin ducks, 3 thick-billed murres, 1 common murre, and one crested auklet. Large numbers of glaucous-winged gulls and harlequin ducks were observed bathing and preening in the contaminated waters of the saltwater lagoon. Several potential impacts to birds were described, and included 1) attraction of birds to fish contained in the ships hold that could be released to polluted waters, 2) contamination of breeding areas and subsequently of breeding least auklets and their eggs the following spring, 3) the potential release to the sea of unsecured gill nets aboard the vessel and the subsequent danger of entanglement of seabirds and fur seals, and 4) decreased use of nesting cliffs immediately above the grounded ship by thick-billed and common murres and least auklets.

Activity: transport of personnel/equipment/material - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Higgins, K.F. 1977. Duck nesting in intensively farmed areas of North Dakota. J. Wildl. Manage. 41(2):232-242. (UAF)

This paper reports the results of field studies conducted during spring and summer 1969-1974 in the prairie pothole region of North Dakota that assessed the principal factors limiting duck production on intensively cultivated land. Species observed nesting in the study area included mallard, pintail, shoveler, green- and blue-winged teal, gadwall, and lesser scaup. Habitat within the study area was a combination of cultivated cropland, nontilled uplands, and pothole wetlands. Impacts to ducks associated with grain farming in Alaska are likely to be similar to those found in cultivated areas of the northern United States. The activities of grading/plowing and grazing produced documented direct impacts of changes in vegetation composition to less preferred species and collision with vehicles. Nest densities were 12 times greater on untilled upland than on annually tilled cropland. Hatched-clutch densities were 16 times greater on untilled upland than on annually tilled cropland. Hatched-clutch densities on untilled uplands were lowest in heavily grazed pastures, whereas the highest densities were found in first-year idled pasture, abandoned wooded farmsteads, road rights-of-way, and dry wetland basins and borders. The greatest diversity of nesting duck species occurred in untilled uplands, followed by growing grain, stubble, and summer fallow. Seventy-two percent or more of all nests except pintails were in untilled upland. Pintails nested in almost equal density in all habitats except growing grain. Only 15% or less of the mallards, blue-winged teal, shoveler, and lesser scaup nested in tilled habitat types. Farm machinery during land tillage destroyed 34% of all nests and 93% of the active nests on cropland.

Activity: grading/plowing; grazing.

Impact: collision with vehicles or structures, or electrocution by powerlines; vegetation composition, change to less preferred or useable species.

Johnson, S.R. 1984. Habitat use and behavior of nesting common eiders and molting oldsquaws at Thetis Island, Alaska, during a period of industrial activity. LGL Alaska Research Associates, Inc. for Sohio Alaska Petroleum Company. (ADF&G-F, Habitat)

This field study was conducted from May through August 1983 on Thetis and Spy Islands, two sand-and-gravel-covered barrier islands in the central portion of the Alaskan Beaufort Sea coast near the mouth of the Colville River delta and Oliktok Point, respectively. Objectives of the study were to 1) determine the number, distribution, and breeding success of common eiders on Thetis Island, 2) enhance common eider nesting habitat on Spy Island, and 3) determine the number and distribution of molting oldsquaws near Thetis Island during the mid-summer molt period. These objectives were chosen in an attempt to determine if gravel stockpiling on Thetis Island during winter, gravel movement from Thetis Island by barge to an artificial island site during summer, and associated construction activity would disturb local populations of nesting eiders and molting oldsquaws. Habitat on Thetis and Spy islands consisted of sand and gravel with varying densities of driftwood (high-density driftwood areas were preferred common eider nesting habitat). The activities of human disturbance and transporting personnel/equipment/material by air produced a documented direct impact of harassment. A low-level flight (altitude not reported) over Thetis Island by a helicopter caused a pair of glaucous gulls to flush from their nest area and a pair of common eiders and an oldsquaw to flush from a meltwater area on the island. Several nests of common eiders were abandoned during egg-laying, the result of humans walking near the nest sites. Eggs in these abandoned clutches were apparently eaten by glaucous gulls. Additional visits by humans to the island during later stages of incubation also led to abandonment of one nest and caused disruption of incubation of eggs and rearing of hatchlings. The limited disturbance to nesting waterfowl on the islands during this study was attributed by the author in large part to the establishment of an aircraft flight corridor and buffer zone that for the most part kept helicopters and fixed-wing aircraft at least 1.8 km (1 mi) from either Thetis or Spy island.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Jones, P.H. 1979. Roosting behavior of long-tailed ducks in relation to possible oil pollution. Wildfowl 30:155-158. (UAF)

This paper reports the results of field observations of up to 2,000 long-tailed ducks (oldsquaws) conducted during the winters of 1976-1977 and 1977-1978 at Scapa Flow, Orkney, Great Britain. The objectives of the study were to determine the feeding and deep-water roosting areas used by the ducks in relation to an oil tanker mooring facility within Scapa Flow. Habitat within the study area was the sheltered waters within Scapa Flow, the type of habitat often used by oldsquaws throughout their range, including Alaska. The activity of transporting oil/gas/water by water produced a documented direct impact of morbidity and mortality due to ingestion of or contact with petroleum. A crude oil spill on 5 March 1977 oiled 14 oldsquaws and an additional 96 birds, primarily auks, during the daytime hours. The author pointed out that a nightime oil spill in Scapa Flow, when ducks are more concentrated at their nighttime roost sites, could result in major losses of ducks.

Activity: transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Kirsch, L.M. 1969. Waterfowl production in relation to grazing. J. Wildl. Manage. 33(4):821-828. (ARL)#

This paper presents the results of a four-year study from 1965 through 1968 in the Missouri Conteau area of North Dakota, on the relationship of waterfowl production to land use, with emphasis on grazing. Pair populations of dabbling ducks, principally blue-winged teal, gadwall, mallard, shoveler, and pintail on grazed and ungrazed plots are compared. In general, the study showed that pair numbers, nesting densities, and nest success were generally reduced by grazing. It also suggests that cover removal such as regular grazing and mowing be discontinued on areas managed primarily for waterfowl production.

Activity: grazing.

Impact: vegetation damage/destruction due to grazing by domestic or introduced animals.

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

In this review article, the interactions between agriculture and wildlife are discussed. The species include bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the contiguous 48 states. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine, during white settlement is attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain-growing areas in Alaska in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep, and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grading/plowing.

Impact: attraction to artificial food source.

Kopischke, E.D. 1964. Unusual mortality for diving ducks. J. Wildl. Manage. 28(4):848-849. (UAF)

This paper reports the death of approximately 90 diving ducks that died by drowning in a drainage structure in southern Minnesota in April 1962. The ducks were primarily canvasbacks and lesser scaup, with a few redhead and ring-necked ducks also present. Age and sex data were not provided. Habitat was a flooded, plowed 16-ha (40-acre) lowland area that had been a cornfield the preceeding year. Inclusion of this reference is justified on the basis of the presence of canvasbacks and lesser scaup in Alaska and the current development of agricultural programs. The activity of draining produced a documented direct impact of entrapment. The ducks were drawn into a 12-inch vertical drainage tile that provided rapid drainage for the flooded field and ultimately dumped into a drainage ditch. The ducks died from drowning after being sucked in by the probably strong current and vortex of the drainage intake.

Activity: draining.

Impact: entrapment in impoundments or excavations.

Korschgen, C.E., L.S. George, and W.L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildl. Soc. Bull. 13:290-296. (UAF)

This paper reports the results of field research conducted September through November 1981 in the upper Mississippi River area (Wisconsin and Minnesota). Disturbances to waterfowl, primarily diving ducks (canvasbacks were most common), by recreational boaters (fishermen and hunters primarily) were recorded to determine the frequency of disturbance and possible energetic implications. The study area consisted of a large backwater area of the river containing extensive areas of aquatic vegetation used for feeding by fall staging and migrating ducks. Although conditions in the study area may not directly comparable to conditions found within Alaska, large waterbodies are used in Alaska for feeding and resting by waterfowl during fall migrations, and boat traffic could be expected to affect these birds in a manner similar to that described during this study. The activity of transporting personnel/equipment/material by water produced a documented direct impact of harassment. Conclusive results showed an average of 17.2 boats per day produced 5.2 disturbances to ducks per day. Diving ducks were estimated to have left the staging area 19 times during the study period because of human disturbance. Data were not recorded for the distance between boats and the flushed birds. Flushing distance of ducks did increase as fall progressed. Minimum flight time per disturbance for flocks of canvasbacks was 4.43 ± 3.72 (SD) min or at least 23 min per day. Minimum flight time for all diving ducks was 3.4 ± 2.75 (SD) min per disturbance or at least 18 min per day. The mean flock size of disturbed canvasbacks was 12,474; the flock size for all diving ducks was 7,982.

Activity: transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Lambert, G., D.B. Peakall, B.J.R. Philogene, and F.R. Engelhardt. 1982. Effect of oil and oil dispersant mixtures on the basal metabolic rate of ducks. Bull. Environ. Contam. Toxicol. 29(5):520-524. (UAF)#

Wild-strain adult mallards (Anas platyrhynchos) were kept in groups of three or four birds. Treatment for each bird included two exposures to seawater alone, a few days apart, to establish the basal metabolic rate (BMR) of each individual bird, then a one-time exposure to either Prudhoe Bay Crude Oil (PBCO), Corexit 9527, or PBCO and Corexit 9527. After exposure to one of the pollutants, the bird was exposed two more times to seawater alone 4 to 8 days and 8 to 14 days after, in order to follow the effect of the pollutant over a two-week period.

After exposure to oil, the birds were frequently observed shivering, suggesting that the insulating properties of their plumage had been damaged. The birds swimming in water contaminated with dispersant sank to a much lower level than normal. It was also noticeable that the birds could not shake or preen the water off their plumage as usual. Birds exposed to the mixture of PBCO and Corexit 9527 were indistinguishable after a few minutes from birds exposed to oil alone, despite the fact that the oil was effectively dispersed by the Corexit. Finally, the experiment showed that oiling caused an increase in the metabolic rate, although it seems to increase the damage to plumage, which leads to progressive waterlogging.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Lehnhausen, W.A., and S.E. Quinlan. 1981. Bird migration and habitat use at Icy Cape, Alaska. Unpubl. Mss. USFWS, Anchorage, AK. 298 pp. (ADF&G-F, Habitat)*

This reference reports the results of field studies conducted May through September 1980 on the use of the Icy Cape area of northwestern Alaska by wildlife. A major component of the studies involved quantifying bird migration past Icy Cape and local use of the area by birds. The Icy Cape area is part of an extensive barrier island/lagoon system (Kasegaluk Lagoon). Habitat within the area includes sparsely vegetated barrier islands, a shallow lagoon, salt marsh, tundra, and freshwater wetlands. The activities of transporting personnel/equipment/material by air and human disturbance produced a documented direct impact of harassment. Aircraft flying at altitudes of 15-60 m (50-200 ft) over the barrier islands and the lagoon disturbed nesting, feeding, and resting birds. Common eiders flushed off their nests in mass panic flights when overflown by aircraft at low altitudes. Molting oldsquaws frequently moved from shore or dove as aircraft passed overhead. Glaucous gulls, arctic terns, and black brant flushed from the lagoon or from the barrier islands when overflown by aircraft at low altitudes. During fall migration, flocks of 100-500 black brant on salt marsh areas flushed when humans on the ground were 3-4 km (1.9-2.5 mi) away. Researchers conducting bird surveys also caused nesting birds to flush from their nests. The authors recommended that human activity on the barrier islands be restricted between 15 June and 15 September to protect nesting and molting birds. Several recommendations regarding the prohibition or restriction of development activities (e.g., oil and gas exploration and development, gravel sources, staging areas) were proposed for the barrier island/lagoon systems/nearshore waters. These recommendations were based on perceived potential impacts to the birds of the area and their habitat.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Lemmetyinen, R. 1966. Damage to waterfowl caused by waste oil in the Baltic area. Soum. Riista 19:63-71. [In Finnish with English summary and table and figure headings.] (UAF)

This paper reviews the losses of waterfowl to waste oil dumped from oil tanker ballasts and holds in the Baltic Sea off southeastern Sweden during the late 1940's to the mid 1960's. Species that were discussed in this paper were common scoters and oldsquaws (long-tailed ducks). Latitude and water temperature within the discussed area are similar to that found in parts of Alaska and used by oldsquaws. Specific habitat descriptions were not provided. The activity of transporting oil/gas/water by water produced a documented direct impact of mortality due to ingestion or contact with petroleum. Records for 4 yr during the 1950's indicated approximately 95,000 birds, mainly oldsquaws, died from ingestion or contact with waste oil within the Baltic Sea. In 1960 and 1962, tens of thousands of dead birds, both oldsquaws and scoters, were reported. A ten-fold decline in the number of oldsquaws migrating through Finland from 1937-1940 to 1958-1960 was attributed to waste oil dumping in the Baltic area.

Activity: transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Leppakoski, E. 1973. Effects of an oil spill in the northern Baltic. Mar. Pollut. Bull. 4(6):93-94. (UAF)*

This paper reviews the results of studies conducted after a crude oil tanker ran aground on May 1, 1969, and spilled approximately 150 tons of crude oil in the Baltic Sea near Turku, southwest Finland. Eiders (species were not reported) were the only group of birds discussed in this paper. Latitude and water temperature within the area of the oil spill are similar to that found in parts of Alaska and used by eiders. Detailed habitat descriptions were not provided. The activity of transporting oil/gas/water by water produced a documented direct impact of mortality due to ingestion or contact with petroleum. It was estimated that 25-33% (2,400-3,000 birds) of the nesting eider population of the oil-polluted area died in 1969. It was recommended that ships carrying oil or other floating chemicals be equipped with spill containment booms, that the use of emulsifiers be avoided, and that to the extent possible, spilled oil be removed by mechanical means.

Activity: transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Livezey, B.C. 1980. Effect of selected observer-related factors on fates of duck nests. Wildl. Soc. Bull. 8: 123-128. (UAF)

The objective of this field study conducted during the years 1976 through 1978 at Horicon National Wildlife Refuge, Wisconsin, was to test for effects of investigators on the fates of duck nests. Blue-winged teal were the most abundant duck present on the study area, although mallards, shovelers, and pintails were also present. A description of nesting habitat in the study area was not provided. This study is applicable to Alaska, as the species of ducks observed in this study also nest within Alaska. The activity of human disturbance produced a documented direct impact of active harassment. Conclusive results indicated that hens occasionally deserted nests after being located by the investigator, especially prior to the fourth day of egg laying. The rate of nest abandonment doubled if more than one person visited the nest.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

McEwan, E.H. 1980. Uptake and clearance of petroleum hydrocarbons by the glaucous-winged gull and mallard duck. Can. J. Zool. 58(5):723-726. (USFWS) #

Glaucous-winged gulls and mallard ducks fed tritiated crude oils showed a rapid uptake of labelled hydrocarbons into tissues and plasma. About 45% of the ingested oil was excreted. After 24 hours, tritiated hydrocarbon concentrations in the plasma and tissues declined to background level except for bunker-C-fed birds and stressed, oil-fed gulls.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Mickelson, P.G. 1975. Breeding biology of cackling geese and associated species on the Yukon-Kuskokwim Delta, Alaska. Wildl. Monogr. No. 45. (UAF)

This paper reports the results of field studies conducted May through September 1969-1972 on the Yukon-Kuskokwim delta that examined the breeding biology of cackling Canada geese, black brant, emperor geese, white-fronted geese, and spectacled eiders. Habitat within the study area was wet meadow interspersed with numerous tidal sloughs and shallow ponds. The activities of human disturbance and transport of personnel/equipment/material by water produced documented direct impacts of harassment and increased susceptibility to predation. Conclusive results indicated that about half of all losses of goose and eider eggs and young were the result of human-induced predation. Parasitic jaegers and glaucous gulls preyed on eggs in nests from which females were flushed by humans and on goslings that were separated from their parents. Humans on foot, in addition to increasing rates of predation on eggs and young, also caused desertion of nests, the result of repeated nest-site visits during the early egg-laying period. Boat traffic on sloughs or rivers also caused separation of young and adults and increased rates of predation on young by gulls and jaegers.

Activity: human disturbance; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Mundinger, J.G. 1976. Waterfowl response to rest-rotation grazing. J. Wildl. Manage. 40(1):60-68. (UAF)*

This paper reports the results of field research conducted during the summer of 1973 and the spring and summer 1974 in Montana that examined the effects of rest-rotation grazing on waterfowl production on stock-water reservoirs. Breeding ducks and broods recorded on the study area primarily included mallard, pintail, American widgeon, gadwall, shoveler, blue- and green-winged teal, and lesser scaup. Habitat surrounding the water reservoirs was primarily grassland. Although the habitat in Montana is not directly comparable to that found in Alaska and used by nesting ducks, the effects of grazing are likely to be similar. The activity of grazing produced a documented direct impact of vegetation damage/destruction due to grazing. Conclusive results indicated that the greatest densities of breeding pairs were recorded on pastures that were rested (not grazed) during the previous year. This high use of rested pastures was thought to be the result of increased residual vegetation providing increased nesting cover at the beginning of the nesting season. Pastures that were heavily grazed, particularly during summer and fall the previous year, contained the lowest densities of breeding ducks. Pastures that received early season grazing during the current year showed reduced use by breeding ducks. Pastures grazed the previous year but rested or having deffered (summer or fall) grazing during the current year showed increased use by late-nesting species of ducks, the result of increased cover when these species were ready to nest.

Activity: grazing.

Impact: vegetation damage/destruction due to grazing by domestic or introduced animals.

Neff, J.A. 1955. Outbreak of aspergillosis in mallards. J. Wildl. Manage. 19(3):415-416. (UAF)

This paper reports observations of an outbreak of aspergillosis in ducks (primarily mallards) during January 1949 near Boulder, Colorado. Ducks were wintering on two open-water lakes and were flying to farm stubble and cornfields to feed. Ages and sexes of the affected ducks were not provided. Although large numbers of ducks do not winter near currently developed agricultural areas in Alaska, the potential for attracting and concentrating ducks at grain fields and establishing conditions conclusive to the spread of disease at other times of the year does exist. The activities of grading and plowing and solid waste disposal produced a documented direct impact of attraction to an artificial food source. Approximately 1,000 to 1,100 ducks, mostly mallards, were found dead or dying of aspergillosis along the lakes. On a nearby farm field, over a foot of moldy ensilage had been spread over the snow, to be plowed in at a later date. Ducks from the lakes had been observed feeding on the ensilage during a period when their normal feeding grounds were covered with snow. This circumstantial evidence led to the conclusion that the epizootic was caused by the ducks feeding on the moldy ensilage and was reinforced when the epizootic suddenly ended as the ducks returned to feeding at their normal feeding grounds and abandoned feeding at the ensilage covered field.

Activity: grading/plowing; solid waste disposal.

Impact: attraction to artificial food source.

Nelson, U.C., and H.A. Hansen. 1959. The cackling goose - its migration and management. Trans. N. Am. Wildl. Nat. Resour. Conf. 24:174-187. (UAF)

This paper reviews information on the population status, harvest, migration routes, and breeding range of the cackling Canada geese that nest in the Yukon-Kuskokwim delta. Data from the 1920's through the 1950's were reviewed and used to delineate possible migration routes and rates of mortality. Specific habitat descriptions for areas used by geese were not provided. The activity of grazing produced a documented direct impact of increased susceptibility to predation. It was briefly mentioned that reindeer in the Kotzebue Sound area were observed eating eggs and nests of <u>ducks</u> and also trampling nests. The author speculated that cackling Canada geese nesting in small isolated colonies along the coast of the Kotzebue Sound area (as reported from the late 1800's and that were not present there by the 1950's) could have been destroyed quite readily by the introduction of reindeer.

Activity: grazing.

Impact: parasitism and predation, increased susceptibility to.

Nieman, D.J., and H.J. Dirschl. 1973. Waterfowl populations on the Peace-Athabasca Delta, 1969 and 1970. Can. Wildl. Serv. Occas. Pap. No. 17. (UAF)

This paper reports the results of field studies conducted spring through fall 1969 and 1970 that investigated the habitat preferences and requirements of waterfowl, primarily ducks, during the breeding, molting, and fall staging periods in the Peace-Athabasca delta in northeast Alberta, Canada. The Peace-Athabasca delta is an extensive marsh complex containing extensive muddy lowlands, marshes, shallow ponds and lakes, and meandering streams. Dabbling and diving ducks make extensive use of the area for breeding, molting, and staging. Geese (Canada, snow, and white-fronted geese) make use of the delta primarily during the fall staging period. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of terrain alteration or destruction, water level fluctuations, and changes in sucessional stages of vegetation preferred by waterfowl. Completion and filling of the Bennett Dam reservoir on the Peace River in spring 1968 led to a decreased flow of water to the Peace-Athabasca delta and a decline in water levels throughout much of the delta. Conclusive results indicated a permanent drying of shallow basins, with subsequent changes in patterns of vegetation and use by ducks and geese. Areas formerly preferred by ducks and geese for breeding, molting, and staging received decreased use or were abandoned as water levels declined and preferred habitat deteriorated.

Activity: water regulation/withdrawal/irrigation.

Impact: terrain alteration or destruction (e.g., raptor cliffs); vegetation composition, change to less preferred or useable species; water level or water quality flucuations.

Rattner, B.A., and W.C. Eastin, Jr. 1981. Plasma corticosterone and thyroxine concentrations during chronic ingestion of crude oil in mallard ducks. Comp. Biochem. Physiol. 68c:103-107. (UAA)#

Blood samples were collected from mallard ducks after 6, 12, and 18 weeks of dietary exposure to mash containing 0.015%, 0.150%, and 1.500% crude oil. Plasma corticosterone concentrations in ducks fed mash containing 0.150% or 1.500% Alaskan Prudhoe Bay crude oil were uniformly depressed, when compared to values in untreated control birds. Plasma thyroxine concentration was altered in ducks chronically exposed to crude oil. The observed alteration in corticosterone concentration could reduce tolerance to temperature and dietary fluctuations in the environment.

Activity: transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Renken, R., M. North, and S.G. Simpson. 1983. Waterbird studies on the Colville River delta, Alaska: 1983 summary report. Draft. USFWS, Anchorage. (ADF&G-F, Habitat)

This paper reports general observations of waterbirds gathered incidentally during intensive field studies of swans, geese, and loons on the Colville River delta, Alaska, during May through August 1983. Observations included weather conditions, bird migration and nesting phenology, brant migration and nesting success, mammal activity, and aircraft overflights. Habitat within the study area is a combination of coastal tundra, lakes, and river delta. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Except during sensitive periods (arrival, molt, staging), most birds did not seem to be disturbed by aircraft at altitudes greater than 100 m (328 ft). On three occasions [dates not provided] when single-engine aircraft flew overhead at 30-40 m (100-130 ft), a pair of tundra swans and 15 geese [species not specified] and other birds were flushed. On 9 August, when geese were staging in flocks, a helicopter at an altitude of 150 m (500 ft) and 1 km (0.6 mi) distant flushed all 130 white-fronted geese and half of the 29 Canada geese that were feeding and roosting in a tapped lake basin. Nearly all geese circled and returned to the site within 10 min. Pintails and mallards at the same site reacted only with alert postures.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Rosen, M.N., and A.I. Bischoff. 1950. The epidemiology of fowl cholera as it occurs in the wild. Trans. N. Am. Wildl. Nat. Resour. Conf. 15:147-154. (UAF)

This paper reviews literature and field observations by the authors on the occurrence and the ecology of fowl cholera, primarily within California, during the late 1940's. Ducks, gulls, and coots (no species specified), along with domestic poultry, were reported infected with fowl cholera. Habitat descriptions were not provided for locations where outbreaks occurred. As this disease is found in domestic poultry and may be enzootic in wild waterfowl, outbreaks could occur within Alaska, particularly near areas where poultry are raised. The activity of solid waste disposal produced an indirect impact of disease transmission from domestic species. Large numbers of dead chickens and chicken parts (tentative results indicated the presence of fowl cholera) were found at open garbage dumps near San Jose, California, in December 1948. Circumstantial evidence suggested that gulls (that are relatively resistant to fowl cholera) feeding on the chicken carcasses directly transmitted the pathogen to nearby ponds where coots and ducks (of unspecified numbers or species) died.

Activity: solid waste disposal.

Impact: introduced wild or domestic species, competition with or disease transmission from.

Sargeant, A.B. 1981. Road casualties of prairie nesting ducks. Wildl. Soc. Bull. 9(1):65-69. (UAF)

This report of field work documents the number of road-killed adult ducks found along roads in eastern North Dakota, April-July 1969-1978, and in northcentral South Dakota, April-July 1970-1972. Species found dead along roads included mallard, pintail, shoveler, blue- and green-winged teal, canvasback, redhead, and lesser scaup. Habitat in the area is intensively farmed and contains seasonal and permanent wetlands dissected and bordered by a grid-like system or roads. The potential for agricultural development in areas of Alaska containing or adjacent to wetlands used by ducks and the probability that impacts are likely to be similar in the two areas justify inclusion of this reference. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision with vehicles. A total of 562 adult ducks of 11 species were found dead along roadsides, victims of collisions with vehicles. Dabbling ducks were more vulnerable than diving ducks to collisions as these ducks use roadside seasonal wetlands and roadside uplands for feeding and nesting. Diving duck mortality occurred at sites where semipermanent or permanent wetlands abutted roads. Hen dabblers were slightly more vulnerable to collisions than drakes, the probable result of trips back and forth to the nest. Drake recklessness during hen pursuit flights likely contributed to the increased vulnerability of males during May and June. Eighty-four percent of the dead ducks were found during May and June, the peak period of nesting by dabbling ducks. Early nesting species (e.g., mallard, pintail) were more vulnerable to collisions with vehicles than were late-nesting ducks (e.g., blue-winged teal, shoveler). Relative to the amount of traffic, the maximum annual mortality occurred on a narrow surfaced highway bordered by wetlands in many places and used by local traffic, as opposed to a four-land interstate highway and unsurfaced local service roads. The author estimated that 4,500 ducks died annually from collisions with vehicles in the prairie pothole region of North Dakota.

Activity: transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Schorger, A.W. 1947. The deep diving of the loon and old-squaw and its mechanism. Wilson Bull 59(3):151-159. (UAF)

This review paper examined the depths to which loons and oldsquaws dive and the physiological adaptations that allow these birds to dive to such depths. References that were reviewed were primarily from the 1930's and 1940's. The depths to which the ducks dove were determined from records and observations of ducks caught in gill nets fished within the Great Lakes. Thousands of ducks were reported killed from entanglement, with one fisherman reporting 27,000 ducks caught in his nets March-May 1946. Although it was not stated within the article, interpretation of the examples presented suggested that oldsquaws entangled within the fishing nets were wintering birds. The activity of netting produced a documented direct impact of entanglement in fishing nets.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Schweinsburg, R. 1974. Disturbance effects of aircraft to waterfowl on North Slope lakes, June 1972. Pages 1-48 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 5. (UAF)

This study was conducted June 20-25, 1972, on small lakes within 48 km (30 mi) of the Babbage River and within 24 km (15 mi) of the Beaufort Sea, northern Yukon Territory, Canada. The objectives of the study were to determine the effect of floatplane traffic on the number and behavior of waterfowl on lakes, to determine if there was any variability among species of ducks in their reaction to aircraft, to determine if the size of the lake influenced the bird's responses, and to determine if habituation of the birds to the floatplane operation occurred. The predominate species observed were scaup, scoters, oldsquaw, and widgeon, with lesser numbers of pintail, shoveler, and canvasback also present. Habitat within the study area was coastal tundra. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Conclusive results showed the numbers of ducks present on a small (0.21 km^2 [0.08 mi^2]) lake were reduced by 60% from those present prior to disturbance, after four days of disturbance (five or six hourly landings per day by a Cessna 185). The number of ducks that remained on the lake began to stabilize on the third day of disturbance. Tentative results indicated that patterns of feeding and sleeping activities of birds became irregular, although the time spent in each activity was generally the same. Information concerning disturbance to ducks on intermediate or large lakes or species-specific reactions to disturbance was inconclusive.

[Reviewer's Note: As pointed out by the author, insufficient baseline data were obtained (one day's worth) and severely limited the ability to determine the effects of disturbance to ducks other than those effects that were most obvious.]

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Schweinsburg, R.E., M.A. Gollop, and R.A. Davis. 1974. Preliminary waterfowl disturbance studies, Mackenzie Valley, August 1972. Pages 232-257 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 6. (UAF)

The purpose of this field study was to determine the reactions of waterfowl (surface-feeding and diving ducks, loons, and grebes) to repeated harassment by float-equipped aircraft on small lakes in late summer. The study was conducted during August 1972 on two lakes in the Mackenzie River valley, Northwest Territories, Canada. Habitat types surrounding the lakes were stands of open black spruce or closed stands of birch and spruce similar to those found in much of interior and southcentral Alaska. The activity of transporting personnel/equipment/material by air produced documented direct impacts of passive and active harassment. Adult birds without young were generally more sensitive to disturbance than broods and brood-rearing females and usually flew at the approach of the aircraft. [Brood-rearing females may have been equally sensitive to disturbance but reluctant to leave their broods.] Distances between the aircraft and the disturbed ducks were not reported. Nonbreeding and molting birds were less tolerant of harassment, with the majority of birds leaving the lake by flying, overland travel, or by moving into small streams connected to the lake. Incidental observations of waterfowl near an established seaplane base indicated that small numbers of waterfowl became tolerant of aircraft and were able to withstand repeated disturbance.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sellers, R. 1979. Waterbird use of and management considerations for Cook Inlet state game refuges. Draft rept. ADF&G, Anchorage. 42 pp. (HD)

This field study, conducted during the summer of 1978, had several objectives, including documentation of the response of waterfowl to aircraft operation, documentation of waterfowl production and habitat use, and assessment of public opinion on use and management of refuge lands. The study area in southcentral Alaska contained three coastal marshes - Susitna Flats, Palmer Hay Flats, and Goose Bay. Ducks and geese were the primary species studied, although shorebird and other bird activity were recorded. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Tentative conclusions reached by the author were that 1) geese were generally more subject to disturbance than ducks, 2) helicopters produced a greater reaction from waterfowl than did planes flying at the same altitude, 3) and waterfowl, particularly ducks, can become habituated to aircraft flying above 120 m (400 ft), provided there is not a direct association with subsequent active harassment. Aircraft use on the Palmer Hay Flats has been implicated in changes in activity patterns of and premature southward migration of fall staging lesser Canada geese.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Slaney, F.F., and Co. 1973. Environmental effects assessment, Voyageur air cushion vehicle, Mackenzie Delta, N.W.T. Vol. II:Field Studies. Environmental Protection Service, Environment Canada. (UAF)

This field study was conducted during February, March, and August 1973 to assess the effects of a large air cushion vehicle (ACV) on the vegetation and wildlife of the Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, Canada. Reactions of tundra swans, black brant, white-fronted geese, greater scaup, and dabbling ducks to the ACV during August 1973 were recorded. Habitat within the study area was coastal tundra. The activity of transporting personnel/equipment/material by land produced documented direct impacts of harassment and collision with vehicles. Tundra swans flushed an average of 430 m (1,400 ft) [n = 17, range 69-823 m (225-2,700 ft)] ahead of the ACV. Larger groups tended to flush at greater distances than did solitary birds. A flock of 70 black brant became less tolerant of the ACV during repeated passes and increased their flushing distance from 225 m (725 ft) on the first pass to 1,190 m (3,900 ft) by the third pass. Brant displayed alertness to the sound of the ACV when the machine was out of sight and from 1.2-1.6 km (3/4-1 mi) distant. White-fronted geese flushed an average of 225 m (725 ft) [n = 5, range 91-550 m (300-1,800 ft)] from the ACV, with larger flocks generally flushing at greater distances. Dabbling ducks were relatively tolerant of the ACV, flushing an average of 83 m (270 ft) [n = 6, range 23-228 m (75-750 ft)] from the machine. One molting mallard was overrun on three occasions by the ACV with no apparent harmful effects. Greater scaup were relatively intolerant of the ACV, flushing at distances of 730 m (2,400 ft) and 1,200 m (3,900 ft). The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. White-fronted geese, Canada geese, and dabbling ducks flushed in response to aircraft overflights at distances ranging from 60 m to 1,980 m (200 ft to 6,500 ft).

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: clearing and tree harvest; draining; drilling; filling and pile-supported structures (aquatic); grading/plowing; grazing; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: aquatic vegetation, destruction or change in composition; collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to; terrain alteration or destruction (e.g., raptor cliffs); vegetation composition, change to less preferred or useable species; vegetation damage/destruction due to grazing by domestic or introduced animals; vegetation damage/destruction due to hydraulic or thermal erosion, etc.; water level or water quality fluctuations.

Stout, I.J., and G.W. Cornwell. 1976. Nonhunting mortality of fledged North American waterfowl. J. Wildl. Manage. 40(4):681-693. (UAF)

This review paper summarizes the reported nonhunting mortality of wild waterfowl for North America for the period 1930-1964, based on data from the open literature, unpublished federal reports, a questionaire, and band recoveries. Data were summarized on mortality from collisions, weather, predation, pollution, diseases, poisons, and miscellaneous factors. Data were compiled for dabbling ducks, diving ducks, geese, and swans. The activities of transporting personnel/equipment/material by air and land produced a documented direct impact of collision with vehicles or electrocution by powerlines. Collision mortality (n = 3,015 for all waterfowl combined) was 0.1% of the total sample (n = 2,108,880). Collisions with utility wires and automobiles were the most frequent causes of mortality. The activities of transporting oil by water, processing oil/gas, processing minerals, and chemical application produced a documented direct impact of mortality due to contact with or ingestion of petroleum, petroleum products, or chemicals. Mortality from pollution (n = 13,944) was 0.6% of the total sample and involved primarily oil-contaminated diving ducks. Various chemicals and detergents were reported to have killed waterfowl, particularly in the Central Flyway where pollution from mines was prevalent. Losses of waterfowl to pesticides were also reported. The activity of netting produced a documented direct impact of entanglement in fishing nets. Approximately 51,000 waterfowl, primarily diving ducks, drowned in fishing nets. Mortality from various avian diseases was the greatest component (87.7% or 1,873,970 birds) of the total reported mortality.

Activity: chemical application; netting; processing minerals (including gravel); processing oil/gas; transport of oil/gas/water - water; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; entanglement in fishing nets, marine or terrestrial debris, or structures; morbidity or mortality due to ingestion of or contact with petroleum.

Strang, C.A. 1980. Incidence of avian predators near people searching for waterfowl nests. J. Wildl. Manage. 44(1):220-222. (UAF)#

The object of this study was to determine if avian predators may learn to forage in the vicinity of people if such behavior increases feeding success. Strang observed glaucous gulls, parasitic jaegers, and long-tailed jaegers as they foraged in areas of lowland tundra within the Clarence Rhode National Wildlife Range.

According to the study, only parasitic jaegers were apparently drawn to people, but some observations indicate that both jaegers and gulls sometimes take eggs from exposed waterfowl nests when people are nearby.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Sugden, L.G. 1976. Waterfowl damage to Canadian grain: current problems and research needs. Can. Wildl. Serv. Occas. Paper No. 24. 25 pp. (UAF)*

This excellent review paper examined the problem of attraction of waterfowl to grain fields and the subsequent damage to unharvested grain by feeding waterfowl in the Canadian provinces of Alberta, Manitoba, and Saskatchewan. Papers reviewed were from the 1940's through the 1970's and primarily discussed waterfowl/farming problems in the Canadian prairie provinces and the prairie lands of the northcentral United States. Although the habitat types in these areas are not strictly comparable to those in Alaska, similar conflicts may occur with increased development of grain farming in Alaska. Age, sex, or species-specific information concerning waterfowl was not presented in this paper. The activity of grading and plowing produced a documented direct impact of attraction to an artificial food source. The activities of human disturbance and transporting personnel/equipment/-material by air produced a documented direct impact of harassment. Ducks and geese are attracted to fields of grain in autumn and damage unharvested grain when it is eaten, trampled, and fouled. Crop damage became prevalent in the 1940's, when the practice of allowing grain to ripen in swaths before threshing was initiated. Mallards, which tend to remain later in autumn, are more abundant, and have a greater tendency to field feed, caused the most damage, which was sustained primarily by barley and wheat. Damage to grain by geese tends to be less extensive but more localized. Grain fields near large wetlands tend to attract more ducks and receive greater damage. Various techniques of scaring waterfowl from fields and their relative effectiveness were discussed. Techniques included hazing with aircraft, shooting, and a variety of devices used to generate noise that would frighten waterfowl. Other topics discussed included the extent of damage and the costs to grain farmers, the use of lure crops to keep waterfowl from farm fields, and payment (compensation) programs for grain damage. Suggested practices that might reduce damage to grain included growing nonsusceptible crops (flaxseed or rapeseed), growing grain varieties that can be harvested earlier or without using swaths, using shatter-resistant varieties, leaving high stubble to discourage ducks, delaying cultivation of harvested fields until nearby susceptible crops have been harvested (which allows ducks to feed on waste grain in a place where they can do no damage), and putting areas of marginal farmlands that suffer chronic damage to other uses such as for lure crops or recreation.

Activity: grading/plowing; human disturbance; transport of personnel/-equipment/material - air.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Szaro, R.C., N.C. Coon, and W. Stout. 1980. Weathered petroleum: effects on mallard egg hatchability. J. Wildl. Manage. 44(3):709-713. (ARL)#

This study investigated the results of weathering on the toxic effects of both a crude and a refined oil.

Fresh and weathered No. 2 fuel oil and Prudhoe Bay crude oil were applied in doses ranging from 1 ul to 50 ul to mallard eggs at day eight of incubation. There was no evidence that Prudhoe Bay crude oil became less toxic during 10 days of weathering. The oil killed rapidly. Of those that died due to application of weathered Prudhoe Bay crude, 85% died within six days.

Activity: processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Tiner, R.W., Jr. 1984. Wetlands of the United States: current status and recent trends. Natl. Wetlands Inventory. USDI:USFWS. 59 pp. (UAF)

This review paper presents information on the current status of wetlands in the United States, defines wetlands, their importance, and the major types within the United States, and predicts the future of America's wetlands. Wetlands discussed included estuarine (e.g., salt and brackish tidal marshes, mangrove swamps, intertidal flats) and palustrine (e.g., freshwater inland marshes, bogs, swamps, wet tundra) systems. Wetlands discussed were located throughout the conterminous United States and Alaska, although discussion of wetlands lost to development practices primarily centered on wetlands in the prairie states and the Gulf Coast. Although wetlands in these areas can differ substantially from those found in Alaska, the ecological effects of development practices could be expected to be similar. The activities of draining, filling wetlands, grading/plowing, and water regulation/withdrawal/irrigation produced documented direct impacts of terrain alteration, long-term fluctuations in water level, alteration of prey base, and increased susceptibility to parasitism. The activities of sewage disposal, processing minerals and oil/gas, and chemical application produced a documented impact of destruction of aquatic vegetation. Annual wetland losses within the United States (from the mid 1950's to the mid 1970's) averaged 185,350 ha (458,000 acres): 178,100 ha (440,000 acres) of palustrine losses and 7300 ha (18,000 acres) of estuarine wetland losses. Agricultural development was responsible for 87% of recent national wetland losses. In the Prairie Pothole Region, draining, irrigation projects, and tillage of temporary wetlands has led to substantial losses of habitat used by breeding ducks and concentration of breeding waterfowl populations that could potentially lead to increased likelihood of outbreaks of diseases such as avian cholera or botulism. Wetland drainage also has destroyed habitat important to invertebrates used as food by breeding waterfowl such as pintail and blue-winged teal. Draining and filling of wetlands and deep well irrigation in the Rainwater Basin of Nebraska has caused substantial reductions in wetland areas, causing declines in breeding duck populations, and has caused concentration of wintering and staging waterfowl on remaining wetlands, creating conditions suitable for the spread of disease and subsequent large-scale die-offs of waterfowl. In Chesapeake Bay, pollution from urban and agricultural runoff and industrial and sewage treatment plant discharge, along with natural factors, has led to reduction or elimination of submerged aquatic vegetation that is used by ducks, particularly canvasbacks, for food.

Activity: chemical application; draining; filling and pile supported structures (aquatic); grading/plowing; processing minerals (including gravel); processing oil/gas; sewage disposal; water regulation/withdrawal/irrigation.

Impact: aquatic vegetation, destruction or change in composition; parasitism and predation, increased susceptibility to; prey base, alteration of; terrain alteration or destruction (e.g., raptor cliffs).

Troy, D.M. 1985. Prudhoe Bay Waterflood project environmental monitoring program terrestrial studies, 1984. Draft rept. Prepared for Envirosphere Company by LGL Alaska Research Associates, Inc., Anchorage, AK. 126 pp. (ADF&G-F, Habitat)

This field research report details the results of studies conducted during the summer of 1984, with integration of work conducted during the summers of 1981-1983, that examined the effects of the Prudhoe Bay Waterflood project's West Road and its associated facilities on the surrounding vegetation and bird life. Tundra bird studies were directed at evaluating habitat use by birds, evaluating the effects of traffic on the West Road and related disturbance on birds, and evaluating the effects of habitat alterations such as impoundments on birds. The studies were conducted in the vicinity of the Prudhoe Bay West Dock and Pt. McIntyre, Alaska. Habitat within the study area is coastal tundra. Species studied included Canada, snow, and white-fronted geese, eiders, oldsquaw, dabbling ducks, tundra swans, loons, shorebirds, and songbirds. Breeding and nonbreeding birds [and presumably young-of-the-year after hatching] were studied from June through September. The activity of aquatic (wetlands) filling produced a documented direct impact of water impoundment. Conclusive results showed that the West Road blocked or impeded sheet flow of water, creating impoundments that effectively eliminated or reduced habitat quality during the breeding season for white-fronted geese and king eider.

Activity: filling and pile-supported structures (aquatic).

Impact: water level or water quality fluctuations.

USDI. 1976a. Pages 322-329 and 501-504 in Alaska natural gas transportation system - final environmental impact statement. Washington, D.C. (ARL)#*

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.
2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.
3) Muskoxen may have shifted their traditional summer range by 25.6 km (16 mi) in response to heavy helicopter traffic.
4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.
5) Muskoxen and Canadian geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.
2) Caribou can apparently tolerate winter blasting if they are not hunted.
3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.
4) Waterfowl with young avoid drilling rigs within a 4.3 km (2-2/3 mi) radius.

Activity: drilling; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Vangilder, L.D., and T.J. Peterle. 1983. Mallard egg quality: enhancement by low levels of petroleum and chlorinated hydrocarbons. Bull. Environ. Contam. Toxicol. 30(1):17-23. (UAF)#

This paper reports that petroleum hydrocarbons fed together with a chlorinated hydrocarbon enhance egg quality if fed to mallards at low, environmentally realistic levels. However, when low levels of either petroleum hydrocarbons or a chlorinated hydrocarbon are fed alone to mallards, egg quality is reduced. Egg quality was defined in terms of egg size, the amount and relative proportions of the egg's components, the composition of certain components, egg hatchability, and duckling survivorship.

Activity: chemical application; processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Ward, J., and P.L. Sharp. 1974. Effects of aircraft disturbance on moulting sea ducks at Herschel Island, Yukon Territory, August 8, 1973. Pages 1-54 in W.W.H. Gunn, W.J. Richardson, R.E. Schweinsburg, and T.D. Wright, eds. Studies on terrestrial bird populations, moulting sea ducks, and bird productivity in the western arctic, 1973. Arctic Gas Biol. Rept. Ser., Vol. 29, Chap. 2. (ADF&G-F, Habitat)*

The objective of this field study, conducted from August 2 to 15, 1973, on Herschel Island, Yukon Territory, was to compare the behavior of molting sea ducks under undisturbed and disturbed (helicopter overflights) conditions. Oldsquaws and surf scoters were most common and were the species that were studied, although loons, scaup, eiders, pintails, harlequins, and mergansers were also present in limited numbers. Observations were made of birds present within the sheltered waters along the south shore of Herschel Island, an area protected by spits and offshore barrier islands. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Conclusive results showed that hourly overflights by a helicopter at 100 m (328 ft) caused the majority of oldsquaws and surf scoters to swim away from the helicopter. A small percentage (nine and six for oldsquaws and surf scoters, respectively) of ducks dove in response to the overflights. No apparent long-lasting effect of the helicopter overflights on bird behavior was recorded, nor were birds driven from the study area. Helicopter overflights at 300 m (1,000 ft) did not affect the behavior of the molting sea ducks.

[Reviewer's note: see Gollop et al. (1974) for additional information on helicopter overflights of molting sea ducks at Herschel Island.]

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

White, D.H., C.A. Mitchell, L.D. Wynn, E.L. Flickinger, and E.J. Kolbe. 1982. Organophosphate insecticide poisoning of Canada geese in the Texas panhandle. J. Field Ornithol. 53(1):22-27. (UAF)*

This paper reports the discovery of 1,600 dead waterfowl on 26 January 1981 at a playa lake in the Texas panhandle. The dead birds included approximately 1,480 Canada geese, 20 white-fronted geese, 75 mallards, and 25 pintails. No information on ages or sexes of the dead birds was provided. Conclusive laboratory analyses of tissues from a sample of the dead geese indicated poisoning by parathion and methyl parathion. Parathion and methyl parathion were also detected on winter wheat stems and leaves found in the digestive tracts of dead geese. Crop lands surrounding the playa lake were planted with winter wheat, and one field received an aerial application of parathion/methyl parathion 2 d prior to the death of the waterfowl. The authors recommended that less toxic materials, such as malathion, be used to control insects on grain crops when waterfowl are in the vicinity of treatment. Impacts of agricultural chemicals to waterfowl in Alaska could be expected to be similar to those found elsewhere if similar chemicals are used. The activities of chemical application and grading and plowing produced documented direct impacts of morbidity and mortality due to ingestion of chemicals and attraction to an artificial food source.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Woodward-Clyde Consultants. 1982. Kuparuk Waterflood environmental studies. Draft final report. Prepared for ARCO Alaska, Inc., by Woodward-Clyde Consultants, Anchorage, AK (ADF&G-F, Habitat)

This report of field research conducted during July, August, and September 1982 discusses studies of oceanographic and coastal processes, marine and anadromous fishes, benthic biota, and birds near Oliktok Point, Alaska, that were designed to gather information relating to the potential environmental impacts of construction and operation of a dock and oilfield waterflood intake facility. Species observed included molting and staging black brant, white-fronted geese, and oldsquaw. King eider, glaucous gulls, and loons were also studied. No age or sex information was presented for those birds studied. Habitat in the study area was coastal tundra and lagoon-spit-barrier island complex. The activities of transporting personnel/equipment/material by air and human disturbance produced a documented direct impact of passive harassment. Brant flushed 200-300 m (600-1,000 ft) from a helicopter that approached at an altitude of 20 m (100 ft). When overflown by a helicopter at 60-90 m (200-300 ft) altitude, brant would assume an alert posture but would seldom flush unless repeated overhead passes were made by the helicopter. When approached by a human on foot, brant assumed an alert posture at about 150 m (500 ft) and flew if a closer approach by the human took place. White-fronted geese during the molt would form into a tight group and swim away from shore in an alert posture when overflown by a helicopter at 60-90 m (200-300 ft). During the staging and migration period, white-fronted geese reacted similarly but if circled by a helicopter would flush. During and after the molt, oldsquaws would typically dive under water, usually when the helicopter was directly overhead.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Wright, J.M., and S.G. Fancy. 1980. The response of birds and caribou to the 1980 drilling operation at the Point Thomson #4 well. Final rept. Prepared by LGL Ecological Research Associates, Inc., for Exxon Co., USA. (ADF&G-F, Game)

This paper reports the results of field research conducted during the summer of 1980 that examined the responses of birds and caribou to an exploratory drilling operation approximately 70 km (43 mi) east of Prudhoe Bay, Alaska. The drill site was located in wet sedge meadow vegetation on the arctic coastal plain within 750 m (2,500 ft) of the Beaufort Sea. Birds observed during the study included loons, shorebirds, songbirds, oldsquaws, eiders, pintails, scoters, and Canada geese. The activities of transporting personnel/equipment/material by air and water produced a documented direct impact of harassment. Molting oldsquaws (35) nesting on a gravel spit left the spit as a helicopter flew overhead at approximately 305 m (1,000 ft) and swam 100 m (325 ft) from shore. These birds returned to shore less than 10 min after the disturbance. A helicopter flying about 1.6 km (1 mi) inland at 125 m (400 ft) AGL caused 300-370 molting oldsquaws to leave the spit and swim alongshore; more than half the birds returned to the spit within 10 min. On one occasion, a small outboard-powered boat passed close alongshore and flushed the molting oldsquaws away from the spit.

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

17. Geese

Table 1. Impacts Associated With Each Activity - Geese

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove	?		?			?	?			?									?				?							
Aquatic vegetation, destruction or change	?		?	?		?	?			?		?	?		?			?	?	?	?	?	?		?	?				?
Attraction to artificial food source												X	?									?								
Barriers to movement, physical and behavioral												?																X		
Collision with vehicles or structures												?		?													X	X	?	
Entanglement in fishing nets, debris																														
Entrapment in impoundments or excavations						?													?	?										
Harassment, active or passive	X				X			X				X		X											X		X	X	X	
Harvest, change in level																														
Introduced wild/domestic species, competition												?	?	?								?								
Morbidity/mortality by ingestion of petroleum				X										?				?	?	X		?			?	?			?	
Parasitism/predation, increased susceptibility					?	?				?		?	X	X													X	?	X	X
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction			?		?	?	?			?		?										?								X
Veg. composition, change to less preferred		?	?	?	?	?	?			?		?	?																	X
Veg. damage/destruction due to air pollution				?	?													?	?	?	?							?	?	
Veg. damage/destruction due to fire/parasitism		?																												
Veg. damage/destruction due to grazing													?																	
Veg. damage/destruction due to erosion					?					X	?	?										?								
Water level or water quality fluctuations			?			?	?			X		?									?									X

X - Documented impact (see text).
? - Potential impact.

17. GEESE - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on geese. Each citation refers to an annotation in the following section, Annotated References to Impacts on Geese. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to geese are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to geese were found for the following activities:

Burning
Channelizing waterways
Draining
Dredging
Fencing
Filling (terrestrial)
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Sewage disposal
Solid waste disposal
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - water

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Blasting:

   a. Harassment, active or passive

      Envirosphere Company 1986
      Gibson and Buss 1972

2. Chemical application:

   a. Morbidity/mortality by ingestion of petroleum

      Babcock and Flickinger 1977
      Blus et al. 1979
      Blus et al. 1984
      Flickinger 1979
      Hamilton and Stanley 1975
      Stout and Cornwell 1976
      White et al. 1982
      Zinkl et al. 1978

3. Clearing and tree harvest:

   a. Harassment, active or passive

      Culbertson et al. 1971

4. Drilling:

   a. Harassment, active or passive

      Barry and Spencer 1976
      Envirosphere Company 1986
      Sopuck et al. 1979
      USDI 1976a

5. Filling and pile-supported structures (aquatic):

   a. Veg. damage/destruction due to erosion

      Envirosphere Company 1986

   b. Water level or water quality fluctuations

      Troy 1985

6. Grading/plowing:

   a. Attraction to artificial food source

      Babcock and Flickinger 1977
      Blus et al. 1984
      Flickinger 1979
      Hamilton and Stanley 1975

Kahl and Samson 1984
Klebesadel and Restad 1981
Sugden 1976
White et al. 1982

b. Harassment, active or passive

Culbertson et al. 1971
Gibson and Buss 1972

7. Grazing:

a. Parasitism/predation, increased susceptibility

Jones and Byrd 1979

8. Human disturbance:

a. Harassment, active or passive

Culbertson et al. 1971
Derksen et al. 1982
Eisenhaurer and Kirkpatrick 1977
Envirosphere Company 1986
Gollop et al. 1974
Hampton and Joyce 1985
Hanson and Eberhardt 1971
Kiera 1979
Lehnhausen and Quinlan 1981
MacInnes and Misra 1972
McCabe 1979
Mickelson 1975
Owens 1977
Sopuck et al. 1979
Spindler 1984
Sterling and Dzubin 1967
Sugden 1976
Woodward-Clyde Consultants 1982

b. Parasitism/predation, increased susceptibility

Eisenhaurer and Kirkpatrick 1977
MacInnes and Misra 1972
Mickelson 1975

9. Processing oil/gas:

a. Morbidity/mortality by ingestion of petroleum

Boag and Lewin 1980

10. Transport of oil/gas/water - land, ice:

a. Harassment, active or passive

Gollop and Davis 1974
Sopuck et al. 1979
USDI 1976a
Welling and Johnson 1982
Wiseley 1974

11. Transport of personnel/equipment/material - air:

a. Collision with vehicles or structures

Blokpoel and Hatch 1976
Sopuck et al. 1979

b. Harassment, active or passive

Barry and Spencer 1976
Blokpoel and Hatch 1976
Campbell 1984
Davis and Wiseley 1974
Derksen et al. 1979
Derksen et al. 1982
Envirosphere Company 1986
Gollop and Davis 1974
Gollop et al. 1974
Hogan 1982
Kiera 1979
Lehnhausen and Quinlan 1981
Owens 1977
Renken et al. 1983
Salter and Davis 1974
Sellers 1979
Slaney and Co. 1973
Spindler 1984
Sugden 1976
Timm 1980
USDI 1976a
Welling and Johnson 1982
Woodward-Clyde Consultants 1982

c. Parasitism/predation, increased susceptibility

Barry and Spencer 1976
Derksen et al. 1982
Jones and Byrd 1979

12. Transport of personnel/equipment/material - land, ice:

    a. Barriers to movement, physical and behavioral

        Envirosphere Company 1986
        Hampton and Joyce 1985

    b. Collision with vehicles or structures

        Sopuck et al. 1979
        Stout and Cornwell 1976

    c. Harassment, active or passive

        Culbertson et al. 1971
        Envirosphere Company 1986
        Hampton and Joyce 1985
        Slaney and Co. 1973

13. Transport of personnel/equipment/material - water:

    a. Harassment, active or passive

        Campbell 1984
        Hampton and Joyce 1985
        Mickelson 1975
        Owens 1977
        Sopuck et al. 1979

    b. Parasitism/predation, increased susceptibility

        Jones and Byrd 1979
        Mickelson 1975

14. Water regulation/withdrawal/irrigation:

    a. Parasitism/predation, increased susceptibility

        Sopuck et al. 1979

    b. Terrain alteration or destruction

        Bowhay 1972

Fielder and Perleberg 1983
Gibson and Buss 1972
McCabe 1979
Nieman and Dirschl 1973

c. Veg. composition, change to less preferred

Bowhay 1972

d. Water level or water quality fluctuations

Bowhay 1972
Gibson and Buss 1972
Hanson and Eberhardt 1971
McCabe 1979
Nieman and Dirschl 1973
Sopuck et al. 1979

B. Organization by Impact Category

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to geese were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Grading/plowing

      Babcock and Flickinger 1977
      Blus et al. 1984
      Flickinger 1979
      Hamilton and Stanley 1975
      Kahl and Samson 1984
      Klebesadel and Restad 1981
      Sugden 1976
      White et al. 1982

2. Barriers to movement, physical and behavioral:

   a. Transport of personnel/equipment/material - land, ice

      Envirosphere Company 1986
      Hampton and Joyce 1985

3. Collision with vehicles or structures:

   a. Transport of personnel/equipment/material - air

      Blokpoel and Hatch 1976

Sopuck et al. 1979

b. Transport of personnel/equipment/material - land, ice

Sopuck et al. 1979
Stout and Cornwell 1976

4. Harassment, active or passive:

a. Blasting

Envirosphere Company 1986
Gibson and Buss 1972

b. Clearing and tree harvest

Culbertson et al. 1971

c. Drilling

Barry and Spencer 1976
Envirosphere Company 1986
Sopuck et al. 1979
USDI 1976a

d. Grading/plowing

Culbertson et al. 1971
Gibson and Buss 1972

e. Human disturbance

Culbertson et al. 1971
Derksen et al. 1982
Eisenhaurer and Kirkpatrick 1977
Envirosphere Company 1986
Gollop et al. 1974
Hampton and Joyce 1985
Hanson and Eberhardt 1971
Kiera 1979
Lehnhausen and Quinlan 1981
MacInnes and Misra 1972
McCabe 1979
Mickelson 1975
Owens 1977
Sopuck et al. 1979
Spindler 1984
Sterling and Dzubin 1967
Sugden 1976

Woodward-Clyde Consultants 1982

f. Transport of oil/gas/water - land, ice

Gollop and Davis 1974
Sopuck et al. 1979
USDI 1976a
Welling and Johnson 1982
Wiseley 1974

g. Transport of personnel/equipment/material - air

Barry and Spencer 1976
Blokpoel and Hatch 1976
Campbell 1984
Davis and Wiseley 1974
Derksen et al. 1979
Derksen et al. 1982
Envirosphere Company 1986
Gollop and Davis 1974
Gollop et al. 1974
Hogan 1982
Kiera 1979
Lehnhausen and Quinlan 1981
Owens 1977
Renken et al. 1983
Salter and Davis 1974
Sellers 1979
Slaney and Co. 1973
Spindler 1984
Sugden 1976
Timm 1980
USDI 1976a
Welling and Johnson 1982
Woodward-Clyde Consultants 1982

h. Transport of personnel/equipment/material - land, ice

Culbertson et al. 1971
Envirosphere Company 1986
Hampton and Joyce 1985
Slaney and Co. 1973

i. Transport of personnel/equipment/material - water

Campbell 1984
Hampton and Joyce 1985
Mickelson 1975
Owens 1977
Sopuck et al. 1979

5. Morbidity/mortality by ingestion of petroleum:

    a. Chemical application

        Babcock and Flickinger 1977
        Blus et al. 1979
        Blus et al. 1984
        Flickinger 1979
        Hamilton and Stanley 1975
        Stout and Cornwell 1976
        White et al. 1982
        Zinkl et al. 1978

    b. Processing oil/gas

        Boag and Lewin 1980

6. Parasitism/predation, increased susceptibility:

    a. Grazing

        Jones and Byrd 1979

    b. Human disturbance

        Eisenhaurer and Kirkpatrick 1977
        MacInnes and Misra 1972
        Mickelson 1975

    c. Transport of personnel/equipment/material - air

        Barry and Spencer 1976
        Derksen et al. 1982
        Jones and Byrd 1979

    d. Transport of personnel/equipment/material - water

        Jones and Byrd 1979
        Mickelson 1975

    e. Water regulation/withdrawal/irrigation

        Sopuck et al. 1979

7. Terrain alteration or destruction:

    a. Water regulation/withdrawal/irrigation

Bowhay 1972
Fielder and Perleberg 1983
Gibson and Buss 1972
McCabe 1979
Nieman and Dirschl 1973

8. Veg. composition, change to less preferred:

   a. Water regulation/withdrawal/irrigation

      Bowhay 1972

9. Veg. damage/destruction due to erosion:

   a. Filling and pile-supported structures (aquatic)

      Envirosphere Company 1986

10. Water level or water quality fluctuations:

   a. Filling and pile-supported structures (aquatic)

      Troy 1985

   b. Water regulation/withdrawal/irrigation

      Bowhay 1972
      Gibson and Buss 1972
      Hanson and Eberhardt 1971
      McCabe 1979
      Nieman and Dirschl 1973
      Sopuck et al. 1979

ANNOTATED REFERENCES TO IMPACTS TO GEESE

The annotated bibliography contains only references that discuss documented impacts to geese. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to geese are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Babcock, K.M., and E.L. Flickinger. 1977. Dieldrin mortality of lesser snow geese in Missouri. J. Wildl. Manage. 41(1):100-103. (UAF)

This paper reports observations of widespread mortality of migrating lesser snow geese in western Missouri during late March to mid April 1974. Examination of dead and dying geese indicated the presence of lethal levels of dieldrin. Of the 157 sick or dead snow geese counted at four separate locations in Missouri, most were immature, white-phase males. [Rev. note: Flickinger 1979 also noted that most of the dying or dead dieldrin contaminated geese in Texas were immature white-phase males.] As neither dieldrin or aldrin (which metabolizes to dieldrin) were in use in Missouri during March and April, it was concluded that the snow geese were exposed to aldrin or dieldrin on their wintering grounds, in this case, the newly planted rice fields in Texas some 900 km (500 mi) to the south. Detailed age-sex information of the affected geese or detailed data on habitat were not provided. Impacts of agricultural chemicals to geese in Alaska could be expected to be similar to those found in Texas or Missouri if similar chemicals were used in Alaska. The activities of grading and plowing and chemical application produced documented direct impacts of attraction to an artificial food source and morbidity and mortality due to ingestion of chemicals.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Barry, T.W., and R. Spencer. 1976. Wildlife response to oil well drilling. Can. Wildl. Serv. Prog. Notes No. 67. Canadian Wildlife Service, Edmonton, Alberta. 15 pp. (HD)*

A field study of the effects of oil-well drilling on wildlife in the vicinity of the Taglu G-33 site in the MacKenzie River delta, Northwest Territories, Canada, was conducted during June, July, and August 1971. Species studied included nesting and molting Canada, white-fronted, and snow geese, whistling (tundra) swans, and dabbling and diving ducks. Habitat within the area is coastal tundra. The activity of drilling produced a documented direct impact of passive harassment. Whistling swans, white-fronted geese, Canada geese, pintails, green-winged teal, and scaup were less abundant in plots within 2.5 km (1.5 mi) of the drill rig than in control plots 8 km (5 mi) distant. Molting flocks or family groups of whistling swans, white-fronted geese, Canada geese, and snow geese moved or stayed more than 2.5 km (1.5 mi) from the drill rig. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment and increased susceptibility to predation. Swans and geese flushed, swam, or ran from a helicopter at distances ranging from 10 m to 2.4 km (30 ft to 1.5 mi), depending on species and their stage of incubation or molt. Snow geese would flush from their nests from 0.8 to 2.4 km (0.5 to 1.5 mi) ahead of the helicopter and would begin to return to the nest site when the helicopter was 0.8 km (0.5 mi) past the nest site. Resettling on the nests took up to 45 min after passage of the helicopter, because fights occurred as the disturbed birds crossed the territories of others to regain their own nests. Gulls and jaegers preyed on goose eggs more heavily than usual when the disturbed geese were off their nests. The activity of transporting personnel/equipment/material by water produced a documented direct impact of passive harassment. Ducks and swans either flushed or swam as a supply tug and barge approached.

Activity: drilling; transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Blokpoel, H., and D.R.M. Hatch. 1976. Snow geese, disturbed by aircraft, crash into powerlines. Can. Field-Nat. 90(2):195. (UAF)

This note reports the death or injury of 25 to 75 (depending on the person reporting the incident) blue and snow geese that collided with powerlines after they had been flushed by an aircraft flying overhead at a low altitude (30-60 m [100-200 ft]). It was undetermined whether the death of the geese was from electrocution from or collision with the powerlines. The incident occurred May 8, 1974, in farm stubblefields in the prairies of southern Manitoba near Pilot Mound. No information was provided concerning the age or sex of the injured or killed birds.

Activity: transport of personnel/equipment/material-air.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

Blus, L.J., C.J. Henny, D.J. Lenhart, and E. Cromartie. 1979. Effects of heptachlor-treated cereal grains on Canada geese in the Columbia basin. Pages 105-116 in R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific flyway geese: a symposium. OSU Book Stores, Inc., Corvallis. (UAF)*

This field and laboratory study was conducted to determine the extent and impact of heptachlor insecticide contamination on Canada geese, both resident geese and migrants from Alaska, on two study areas along the Columbia River in Washington and Oregon in 1978. Habitat types within the study areas were not listed. This study is applicable to Alaska because it involves a species found in Alaska, and chemical insecticides undoubtedly are or will at some time be used on cereal grain crops grown in Alaska. The activity of chemical application produced documented impacts of mortality and morbidity due to ingestion of chemicals. Mortality of adult geese was due to ingestion of exposed wheat seed treated with heptachlor for insect control. Resident adults contained more insecticide residues than did migrant geese. Nesting success was decreased for goose eggs containing high levels of insecticide residue. It was not determined if the decreased nesting success was related to embryotoxic effects of the heptachlor or to effects on adults that resulted in nest desertion due to mortality or behavioral aberrations. Recommendations were to 1) improve handling of treated grain to decrease its availability to wildlife, 2) use treated seed only in areas requiring insect control and cessation of prophylactic use, and 3) to replace heptachlor with a safer chemical.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Blus, L.J., C.J. Henny, D.J. Lenhart, and T.E. Kaiser. 1984. Effects of heptachlor- and lindane-treated seed on Canada geese. J. Wildl. Manage. 48(4):1097-1111. (UAF)

This paper reports the results of field studies and laboratory analyses of Canada geese conducted at the Umatilla National Wildlife Refuge (NWR) in Oregon and Washington and at the McNary Recreation area in Washington. Research was conducted during the nesting seasons (March-May) of 1977-1983 and centered on the nesting success and tissue insecticide levels of Canada geese exposed to heptachlor- and lindane-treated wheat seed. Habitat descriptions of nesting islands used by geese within the study area were not reported. The impacts to geese of agricultural use of pesticides in Alaska could be expected to be similar to that reported in other areas. The activities of grading and plowing and chemical application produced documented direct impacts of attraction to an artificial food source and morbidity and mortality due to ingestion of chemicals. Geese were observed feeding in fields during autumn and early winter on exposed heptachlor-treated winter wheat seed. Nonresident geese were less likely to be exposed to treated wheat than resident geese, as they generally arrived in the area after planting of winter wheat was completed and left in spring before seeding of spring wheat. Nonresident geese had lower residues of heptachlor and a lower prevalence of mortality from heptachlor than did resident geese. Ingested heptachlor is readily metabolized to heptachlor epoxide, which is lipid soluble and readily stored in body fat. Late winter and early spring stresses from reproduction, weather, food shortage, or migration result in mobilization of fat reserves containing heptachlor epoxide, and if sufficient residues are mobilized, adverse sublethal effects involving reproduction, behavior, or other aspects may occur, and mobilization may prove lethal to some birds. Residues of heptachlor epoxide in brains of geese found dead in 1978 and 1979 at Umatilla NWR equalled or exceeded lethal levels in most cases. Numbers of breeding pairs of Canada geese at Umatilla NWR declined from 129 pairs in 1974 to about 100 pairs in 1979. The percentage of abandoned eggs at Umatilla NWR increased from 12% in 1974 to 45% in 1975, apparently coinciding with the increased use of heptachlor in the area. Nesting and hatching success in 1978 and 1979 was considerably lower at Umatilla NWR than in other areas where exposure to heptachlor was limited or absent. Residues of heptachlor found in eggs were highest in the Umatilla area during 1978 and 1979. In September 1979, the use of heptachlor was banned in the area near Umatilla NWR. Lindane was used as a substitute in this area in 1979 and in much of the Columbia Basin by 1981. Concurrently, reproductive success of geese increased, adult and egg mortality decreased, and the nesting population increased to 170 pairs (from 100 pairs in 1979) by 1983.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Boag, D.A., and V. Lewin. 1980. Effectiveness of three waterfowl deterrents on natural and polluted ponds. J. Wildl. Manage. 44(1):145-154. (UAF)

This paper reports the results of field research conducted from May through October 1975 and 1976 near Fort McMurray, Alberta, that tested the effectiveness of three types of devices in deterring waterfowl from entering a small series of natural ponds and a tailings pond from an oil sands extraction plant. Species of ducks observed at the natural ponds included lesser scaup, redhead, ringed-neck duck, mallard, blue- and green-winged teal, widgeon, bufflehead, and pintail. Ages or sexes of ducks observed were not reported. Both the natural and the tailings ponds were within the boreal forest zone. The activity of processing oil/gas produced a direct documented impact of morbidity and mortality due to ingestion of or contact with petroleum or petroleum products. Six geese of unspecified species, 42 dabbling ducks, and 65 diving ducks (mostly _Aythya_ spp. - lesser scaup, ring-necked duck) were found dead or moribund in the 150-ha (375-acre) tailings pond that contained both aqueous and bituminous effluent from an oil sands extraction plant. Data suggested that waterfowl were more vulnerable to bitumen fouling during spring migration. Of the three deterrents (a model falcon, a moving series of reflectors suspended from a frame, and a human effigy) tested at the natural ponds, only the human effigy appeared to be effective; diving ducks of the genus _Aythya_ were affected most. The placement of 27 human effigies on the tailings pond was considered effective in reducing the number of waterfowl deaths at the pond during 1976 when compared with the number of birds found at the site when no effigies were present. Most of the waterfowl were suspected to have entered the tailings pond at night, at a time when the visibility of the effigies was minimal. The authors suggested that some means of increasing visibility of the deterrents at night might increase their effectiveness.

Activity: processing oil/gas.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Bowhay, E.L. 1972. Canada goose management on the Columbia and Snake rivers in Washington. Proc. Western State Game Fish Comm. 52: 360-373. (UAF)

The objective of this field study was to determine the changes occurring in the population of nesting Canada geese brought about by the construction of seven dams since 1950 on the Columbia and Snake rivers in the state of Washington. The habitat type surrounding the river and found on islands used by nesting geese was characterized by semidesert vegetation dominated by sagebrush and bunchgrass. Although this habitat type is not found in Alaska, the presence of Canada geese, a species also found in Alaska and the documentation of the effects of hydroelectric impoundments on these geese make this study applicable to Alaska. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of terrain alteration and destruction, and water level fluctuations, and an indirect impact of vegetation composition change to less preferred species. Conclusive results showed that goose nesting activity within the study area was reduced an average of 67% the first year following completion of each of the seven dams. Over 50% of the river islands used for nesting sites were inundated. Additional nesting and breeding habitat was being lost through severe wave erosion of the remaining islands and shorelines, and through the encroachment of undesirable dense stands of vegetation.

Activity: water regulation/withdrawal/irrigation.

Impact: terrain alteration or destruction (e.g., cliffs); vegetation composition, change to less preferred or useable species; water level or water quality flucations.

Campbell, B.H. 1984. Fall activity of airboats and aircraft on Coffee Point, Palmer Hay Flats and their impacts on waterfowl and hunting. Draft rept. ADF&G, Anchorage. 26 pp. (ADF&G, F-Habitat)

This report summarizes the results of a study conducted by the ADF&G during the fall of 1983 that examined the current public attitude on airboat and aircraft use on the Palmer Hay Flats State Game Refuge, quantified the hunting effort at Coffee Point, and documented the amount of aircraft and airboat traffic on the Hay Flats and the reaction of waterfowl to this traffic. A combination of field observations, hunter interviews, and mail questionaires were used to gather data. Observations were made of both ducks and geese during September and October (species-specific observations were not provided). Habitat within the area of study includes river delta, tidal mud flats, small creeks, sloughs, and wetlands. The activities of transporting personnel/equipment/material by air and water produced a documented direct impact of harassment. The reactions of 550 ducks and 2,931 geese to aircraft overflights were recorded. Fifty-five percent of the ducks and all of the geese flushed when overflown by aircraft at altitudes less than 152 m (500 ft) and at distances within 400 m (¼ mi) of the birds. No ducks were flushed by aircraft flying above 152 m (500 ft) and within 400 m (¼ mi) of the birds; 16% of the geese observed flushed under the same conditions of disturbance. Approximately 70% of the ducks and 43% of the geese milled about and returned to the area from which they were flushed; the remainder flew to other locations. Reactions of ducks to aircraft overflights became more severe as fall progressed. Waterfowl resting and feeding along sloughs typically allowed airboats to approach closer before flushing than did birds on ponds, likely the result of limited visibility resulting from meanders in the slough and high slough banks. Resident ducks did not flush until the airboat was on average 69 m (225 ft) away, and resident geese did not flush until the airboat was on average 115 m (375 ft) away. About 52% (25 ducks) of the ducks flushed from sloughs returned after the airboat passed; none of the 63 geese returned. Ducks setting on ponds flushed an average of 197 m (645 ft) from airboats, and nearly 67% returned after the airboat passed. Migrating ducks appeared to be more sensitive to disturbance by airboats than were resident ducks. In October, ducks flushed an average of 400 m (¼ mi) from airboats as compared with an average flushing distance of 137 m (450 ft) (mean of combined values for ducks on ponds and sloughs) in September. All ducks flushed by airboats after October 1 left the area.

[Reviewer's note: Conclusions about the effects of airboats and aircraft should be considered tentative because of the low sample sizes for waterfowl, aircraft, and airboats.]

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Culbertson, J.L., L.L. Cadwell, and I.O. Buss. 1971. Nesting and movements of Canada geese on the Snake River in Washington. Condor 73(2):230-236. (UAF)

This paper reports the results of field studies conducted February through September 1966-1968 on the status, nesting success, and behavior of the western Canada goose in southeast Washington prior to the completion of a series of dams on the Snake River. Geese nested on rock and sand islands that varied from 4-10 ha (9-26 ac). Detailed descriptions of vegetation of the islands were not provided. The activities of clearing, grading and plowing, human disturbance, and transporting personnel/equipment/material by land produced a documented direct impact of harassment. Only 33% of nests and eggs were successful on all islands in 1967 (compared to 80 and 76% in 1966). During 1967, low water levels and good weather were conducive to use of the islands by fishermen and picnickers, and the removal of gravel from one of the nesting islands produced a great deal of noise, factors that were believed to be responsible for desertion of several nests. During 1968, nest and egg success was again reduced (55 and 53%, respectively). The clearing of orchards and farms in preparation of reservoir filling near two of the nesting islands in 1968, along with disturbance from fishermen and picnickers, was believed to have been the major cause of nest desertion.

Activity: clearing and tree harvest; grading/plowing; human disturbance; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Davis, R.A., and A.N. Wiseley. 1974. Normal behavior of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behavior. Pages 1-85 in W.W.H. Gunn, W.S. Richardson, R.E. Schweinsburg, and T.D. Wright, eds. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biol. Rept. Ser., Vol. 27, Chap. 2. (UAF)*

During September 1973, field studies of the reactions of flocks of staging and migrating snow geese to fixed-wing aircraft and helicopter overflights were conducted at several sites along the arctic coastal plain from Demarcation Bay, Alaska, to Blow River, Northwest Territories. Adult, subadult, and juvenile snow geese were present in the flocks that were observed. Habitat within the area of the study was arctic coastal tundra. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Conclusive results showed that flocks of snow geese reacted significantly more strongly to experimental overflights of small aircraft (a Cessna 185 at 152 m [500 ft] above ground level) at 2-hr intervals than at 1/2-hr intervals and suggested that geese were accommodating to some extent to the increased frequency of aircraft overflights. Flocks flushed at a greater distance (3.0 km [1.9 mi]) from the Cessna 185 during the overflights at 1/2-hr intervals than they did during overflights at 2-hr intervals (1.6 km [1.0 mi]); however, geese flew further in response to the 2-hr overflights than to the 1/2-hr overflights. The duration of flock reaction to nonexperimental fixed-wing aircraft overflights was greater the closer the overflight occurred to the flock. Flocks took flight at greater distances in reaction to small helicopters than to small, medium, or large fixed-wing aircraft. Snow geese gradually accommodated to frequent helicopter flights (at 1/2-hr intervals) by flushing closer to the aircraft and flying less once flushed; geese accommodated to fixed-wing flights by flushing further from the aircraft but not flying as far as did the helicopter-disturbed geese. Estimated loss of energy reserves of juvenile snow geese from reduced feeding caused by overflights by fixed-wing aircraft (Cessna 185) at 2-hr intervals (assuming no accommodation to the overflights and that no compensatory feeding took place) was 20.4%; the corresponding figure for small helicopters was 9.5%.

(Reviewer's note: This paper reports the results of the most intensive aircraft disturbance study conducted to date on North Slope snow geese. See also Salter and Davis 1974.)

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Derksen, D.V., W.D. Eldridge, and T.C. Rothe. 1979. Waterfowl and wetland habitat studies. Pages 229-311 in P.C. Lent, ed. Studies of selected wildlife and fish and their use of habitats on and adjacent to the National Petroleum Reserve in Alaska, 1977-1978. National Petroleum Reserve in Alaska 105(c). Field Study 3, Vol. 2, Chap. 8. USDI, Anchorage, Alaska. (HD)*

This field report describes the results of studies conducted June through August 1977 and 1978 within the National Petroleum Reserve, Alaska. Information was obtained on characteristics of wetland vegetation, distribution and abundance of aquatic invertebrates, population numbers and habitat use by waterbirds and molting geese, and response of molting geese to disturbance. Habitat within the areas of study was arctic tundra within large lake, river delta, and northern foothills regimes. Bird species studied included Canada geese, white-fronted geese, black brant, shorebirds, ducks, loons, and swans. The activity of transporting personnel/equipment/-material by air produced a documented direct impact of harassment. Overflights of molting black brant and Canada geese by single-engined aircraft at altitudes of less than 1,525 m (5,000 ft) caused geese to exhibit escape responses. Single-engined aircraft flying at less than 600 m (2,000 ft) created the maximum response. Multi-engined aircraft flying at 750-1,830 m (2,500-6,000 ft) caused geese to flee to water. Helicopter flights between 75-152 m (250-500 ft) over molting geese caused a strong escape response to open water. Passage of a helicopter about 10 km (6 mi) from a flock of feeding brant and Canada geese caused the flock to run to open water, with some of the brant swimming for more than 42 minutes before coming ashore at a site 4.5 km (2.8 mi) from their original location.

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise or scent).

Derksen, D.V., M.W. Weller, and W.D. Eldridge. 1979. Distributional ecology of geese molting near Teshekpuk Lake, National Petroleum Reserve - Alaska. Pages 189-207 in R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific Flyway geese: a symposium. OSU Book Stores, Inc., Corvallis. (UAF)*

This field study was conducted during the summers of 1976-1978 and examined the habitat requirements of molting black brant and Canada, white-fronted, and snow geese in the Teshekpuk Lake area, southeast of Barrow, Alaska. The habitat type within the study area was arctic tundra with numerous thaw lakes. The activity of transporting personnel/equipment/material by air produced a documented direct impact of passive harassment. Brant, Canada geese, and white-fronted geese were sensitive to low-flying single-engine aircraft at elevations less than 1,525 m. There was no response observed to high-flying commercial jet aircraft, but multi-engine motor aircraft at 760 to 1,825 m caused alarm and movement to water. Helicopter flights at 75 to 150 m over molting geese caused a strong escape response. Brant responded more quickly to disturbance than did Canada geese but also returned to normal feeding more quickly. The following recommendations were proposed by the authors: (1) delineate the Teshekpuk Lake molting area as a management unit to protect geese during the molting period and to preserve the habitat of the area; (2) prohibit small aircraft flights over the area at altitudes less than 1,525 m during the month of July; (3) minimize on-ground disturbance during July; (4) avoid modifications of water levels of lakes used by geese; and (5) minimize oil development activities during July.

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Derksen, D.V., W.D. Eldridge, and M.W. Weller. 1982. Habitat ecology of Pacific black brant and other geese moulting near Teshekpuk Lake, Alaska. Wildfowl 33:39-57. (UAF)*

This field study, conducted during June through August 1977 and 1978, examined the behavior, habitat selection, and foods of molting Pacific black brant and Canada geese, with more general observations of white-fronted geese, at two large freshwater lakes near Teshekpuk Lake in arctic Alaska. Habitat within the study area was coastal arctic tundra dominated by lakes of 1-6 km (0.6-3.7 mi) in length. The activities of human disturbance and transporting personnel/equipment/material by air produced a documented direct impact of passive harassment and a documented indirect impact of increased susceptibility to predation. Molting geese and often those in pre- or postmolting flocks responded to humans or aircraft by going to water from feeding or resting sites, often running across large ice floes, when present, to increase the distance between the flock and the disturbance. One white-fronted goose fleeing at the approach of a helicopter was surprised and killed by an arctic fox. The authors recommended complete protection for the Teshekpuk Lake area. Recommendations in lieu of complete protection were 1) to exclude development within 5 km (3.1 mi) of deep-open lakes, especially those with adjacent drained basins and wet-sedge meadows to avoid harassment and reduce the potential for loss of geese from refined fuels, drilling muds, and crude oil, 2) that industrial developments be sited on dry upland tundra away from wet-sedge meadows and drained basins, with activity connected with development restricted to periods when the geese are absent from the area (i.e., September to May), 3) that water sources for drilling or other activities be carefully selected to avoid modification of water levels that may affect the growth of goose food plants along lake shores, 4) that winter vehicle trails be restricted to dry upland areas because of the potential for damage to the wet meadows preferred by feeding geese, 5) that coastal wetlands and intertidal areas not be altered because of their importance as a fall (August) staging area for geese, and 6) that helicopter and fixed-wing aircraft be required to fly above 1,525 m (5,000 ft) because of the disturbance caused to molting geese (from Derksen et al. 1979).

Activity: human disturbance; transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Eisenhaurer, D.I., and C.M. Kirkpatrick. 1977. Ecology of the emperor goose in Alaska. Wildl. Monogr. No. 57. (UAF)

This paper reports the results of field work conducted May through August 1971-1973 and March and April 1973 on the breeding biology, behavior, and distribution of the emperor goose on the Yukon-Kuskokwim delta. Additional observations were made on Adak Island during March and April 1973. Emperor geese of all ages and both sexes were observed during the study. Habitat within the study area included tidal sedge flats, grass flats, tall sedge marsh, lowland and upland tundra, and numerous lakes, streams, and ponds. The activity of human disturbance produced documented direct impacts of increased susceptibility to predation and harassment. During brood surveys, researchers frequently scattered broods and separated goslings from the adults, increasing the vulnerability of these separated goslings to predation by gulls. The authors attributed a significant percentage of the total brood mortality to this human-induced predation.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Envirosphere Company. 1986. Snow geese monitoring program. Chap. 4 in T.C. Cannon and L. Hachmeister, eds., Volume 1. Endicott Environmental Monitoring Program. Draft rept., February 1986. Prepared for U.S. Army Corps of Engineers, Alaska District and SOHIO Alaska Petroleum Co. by Envirosphere Co. [with Alaska Biological Research, Inc.]. (ADF&G-F, Habitat)*

This report describes field studies conducted from June through August 1985 on snow geese in the Sagavanirktok River delta near Prudhoe Bay, Alaska. The objectives of this study were to census the Howe Island snow goose colony [the only knonw snow geese nesting colony in Alaska], to assess nesting success and productivity, to monitor the distribution and movements of snow geese during molting/brood-rearing periods, and to assess the responses of nesting geese and molting geese and their broods to air traffic and construction noise emanating from construction of the Endicott causeway and artificial islands. Habitat within the study area is a combination of coastal tundra, lakes, and river channels and islands.

Nesting period. The activities of blasting, human disturbance, and transporting personnel/equipment/material by air and land produced a documented impact of harassment. Blasting, approximately 13 km (8 mi) from the nesting colony, on average caused 24% of nesting geese to exhibit alert postures following blasts, a response that always lasted less than 30 s. On one occasion, several nonnesting snow geese took flight immediately after a blast. Humans caused nesting pairs to flush from the nest at a distance of 6 m (20 ft). Incubating females and attendant males were alert to the presence of humans at about 200 m (650 ft). One group of nonbreeding geese flew when humans approached to 200 m (650 ft) and subsequently landed 500 m (1,650 ft) distant. Reactions of snow geese to direct overflights (60-457 m [200-1,500 ft] above ground level) were similar for both helicopters and fixed-wing aircraft. Breeding pairs remained on the ground, with females on the nest and attendant males standing or sitting nearby. Nearly all breeding adults visibly assumed alert postures to the overflying aircraft that typically lasted less than 30 s. Nonbreeding snow geese flew as the aircraft approached, landed 200-500 m (650-1,650 ft) distant, and then remained in alert postures for the duration of the overflight (4-6 min). Reactions of the geese to aircraft passing within 1.2 km (0.75 mi) were typically less severe and of shorter duration than those to direct overflights. No overt behavioral reactions of nesting snow geese to road traffic approximately 1.6-3.2 km (1.0-2.0 mi) distant were observed. However, traffic on the Endicott road/causeway caused a statistically detectable behavioral reaction of incubating snow geese. Incubating females exhibited higher levels of alert behavior during the first ½ hr following traffic startups, indicating traffic was a factor influencing goose behavior. In 1985, snow geese did not nest on the east end of Howe Island, the area of highest nest density in 1984. Noise and movement of vehicles on the Endicott road/causeway 1.6 km (1.0 mi) distant [that was not present during the 1984 nesting season] was implicated in this change in nesting distribution (along with possible helicopter landings on the eastern end of the island during early nesting).

Brood-rearing period. The activities of transporting personnel/equipment/-material by land and air, human disturbance, and blasting produced documented direct impacts of harassment and barriers to movement. The activity of aquatic filling produced a documented direct impact of vegetation damage/destruction due to material overlay. Gravel fill placed in one brood-rearing area eliminated use of a portion of this area by geese. Gravel truck traffic prevented a snow goose brood-rearing group from successfully crossing a gravel road on two separate occasions. Another group split into two groups upon approach of a gravel truck, with one group successfully crossing the road and the other failing to cross the road and remaining in the general area for at least 2 wk. Brood-rearing flocks generally ran and swam up to 300 m (1,000 ft) from the road on unsuccessful crossing attempts and more than 2 km (1.2 mi) from the road on successful attempts. Less severe reactions by geese within 1.0 km (0.6 mi) of the road were recorded to vehicles that stopped, traffic start-ups, and exceptional noises from vehicles, and involved alert postures and movement from 10 to 200 m (30 to 650 ft) away from the road. One brood-rearing area within 125 m (435 ft) of the Endicott road was eventually abandoned by geese in favor of a second area 300-700 m (980-2,300 ft) from the road. Snow geese reacted to some helicopters flying at altitudes of up to 450 m (1,500 ft) and up to 1,600 m distant (1 mi). Snow geese moved between 10 and 300 m (30 and 1,000 ft) in response to direct overflights by helicopters between 150-210 m (500-700 ft) and to helicopters below 210 m (700 ft) and within 1 km (0.6 mi). Brood-rearing groups generally sought escape habitat in large waterbodies in response to aircraft overflights. Blasting 13 km (8 mi) distant caused alert reactions lasting less than 2 min duration by 23-29% of adult geese on two of four occasions. Brood-rearing groups several miles from the Endicott road ran from humans on the tundra at distances of 1 km (0.6 mi) and moved up to 1 km (0.6 mi) away from the humans. Brood-rearing geese near the Endicott road appeared to show some habituation to humans near vehicles on the road. Geese within 500 m (1,650 ft) of humans near vehicles either ran to nearby bodies of water, walked away from the road, or exhibited alert behaviors (depending on the distance between the geese and humans). At 500 m from the road, geese failed to respond to humans on the road (n=1). Banding of brood-rearing geese was considered responsible for the permanent movement of six of nine groups between 1.6-4.8 km (1-3 mi) from prebanding locations. Four of the nine groups abandoned brood-rearing areas in which they had been relatively stationary (within 0.5-1.5 km [0.3-0.9 mi]) for the previous 6-14 days.

Activity: blasting; drilling; filling and pile-supported structures (aquatic); human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent); vegetation damage/destruction due to hydraulic or thermal erosion, etc..

Fielder, P.C., and R.L. Perleberg. 1983. Burrow nesting by a Canada goose. Murrelet 64(1):27. (UAF)

This short note documents the use of a burrow in a dirt cliff for nesting by Canada geese during April and May 1982 along a reservoir on the upper Columbia River in northcentral Washington. Habitat within the vicinity of the nest was not described. The lack of documentation of the effects of hydroelectric projects on Canada geese within Alaska justifies inclusion of this reference. The activity of water regulation/withdrawal/irrigation produced a documented direct impact of terrain inundation. A 3-m (10-ft) permanent rise of the reservoir flooded many island nest sites. An increase in shoreline and cliff nesting and a reduction in island nesting was observed after the 3-m (10-ft) permanent reservoir rise occurred. The cliff nest described in this paper was within 2 km (1.2 mi) of four nesting islands that were inundated by the reservoir rise.

Activity: water regulation/withdrawal/irrigation.

Impact: terrain alteration or destruction (e.g., cliffs).

Flickinger, E.L. 1979. Effects of aldrin exposure on snow geese in Texas rice fields. J. Wildl. Manage. 43(1):94-101. (UAF)

This paper reports the results of field observations and laboratory analysis of moribund or dead snow geese that were found in or near fields that had been seeded with aldrin-treated rice. The study area was located in southern Texas and contained largely rice fields and pastures, interspersed with woodlands, two large reservoirs, and numerous small ponds. Detailed investigations of goose mortality were undertaken during March and April 1972-1976. Although rice is not grown in Alaska, other cereal crops are grown that if treated with toxic pesticides could cause similar impacts to geese. The activities of grading and plowing and chemical application produced documented direct impacts of attraction to an artificial food source and morbidity and mortality due to ingestion of chemicals. Snow geese and some white-fronted and Canada geese were attracted to pastures and rice-stubble fields. Newly planted rice fields that were recently flooded also attracted geese and served as the source of the pesticide that cause debilitation or death of geese. Conclusive results indicated that 52 and 60 snow geese, mostly immature white-phase males, were found dying or dead in 1972 and 1974, respectively. Observations of behavior of dying geese and chemical analyses of tissue samples from dead geese indicated the presence of debilitating and lethal concentrations of dieldrin (a metabolite of aldrin). No deaths were observed in 1973 or 1976, when geese left the area before planting of rice occurred. The use of aldrin was also discontinued in 1975. Small numbers of Canada and white-fronted geese died from aldrin poisoning, as did two blue-winged teal. Evidence suggested that geese were adversely affected during spring migration and possibly during nesting. Single moribund geese displaying symptoms of dieldrin poisoning were frequently observed some distance from rice fields. Dieldrin residues were found in the brains of 4 of 5 unsuccessful nesting female snow geese found dead at McConnell River (a nesting colony in Canada used by geese that winter in Texas rice fields) in 1972 and 4 of 5 females from failed nests, whereas only 1 of 10 successful nesters contained such residues.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Gibson, L.W., and I.O. Buss. 1972. Reactions of Canada geese to reservoir impoundment on the Snake River in Washington. Northwest Sci. 46(4):301-318. (UAF)

This paper reports the results of field studies conducted from August 1968 to August 1969 and February-June 1970 that evaluated ecological changes and their effects on Canada geese nesting on the Snake River in southeastern Washington as construction of a dam inundated important breeding sites. Additional objectives included behavioral observations of nesting geese and observations of use of artificial nesting platforms by geese. The study area was the same as that used by Culbertson et al. (1971) during their 1966-1968 similar study. Vegetation descriptions for islands used by nesting geese were not provided. The activities of blasting, grading and plowing, and water regulation/withdrawal/irrigation produced documented direct impacts of harassment, water level fluctuations, and terrain destruction. In 1969, only 10 nests were located on five islands that had previously contained 20 nests; 6 were successful, and the other 4 were abandoned; 3 of these nests were on an island near frequent blasting. Noise from blasting and heavy equipment involved in reservoir preparation and reservoir filling that inundated most of the nesting habitat within the study area were considered to be two of the major factors involved in the decreased nesting success in 1969. In 1970, only one nest was located on one of three small remaining islands, not yet inundated by the rising reservoir.

Activity: blasting; grading/plowing; water regulation/withdrawal/irrigation.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); terrain alteration or destruction (e.g., cliffs); water level or water quality fluctuations.

Gollop, M.A., and R.A. Davis. 1974. Gas compressor noise simulator disturbance to snow geese, Komakuk Beach, Yukon Territory, September, 1972. Pages 280-304 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 7. (UAF)*

This field study, conducted September 7-10, 1972, at Komakuk Beach, Yukon Territory, Canada, was designed to determine if noise from gas compressor stations of a proposed gas pipeline would disturb snow geese that use the Yukon and Alaska coastal plain as a staging and feeding ground prior to their southward fall migration. A sound simulator system was used to generate the types and levels of sound that would normally be encountered at a gas compressor station. Habitat within the study area was coastal tundra. Adult, subadult, and young-of-the-year snow geese composed the flocks that were observed during the study. The activities of transporting oil/gas/-water by land (simulated) and transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Conclusive results indicated that snow geese were disturbed by the sound produced by the gas compressor simulator. Flocks of snow geese that had been feeding within 4.8 km (3 mi) of the sound simulator moved further away when the simulator was first turned on. Some birds eventually returned, venturing to within 2.4 km (1.5 mi) of the simulators. Significantly more geese circled and landed in the control area or near the simulator when it was turned off than did geese in the area of the simulator when it was turned on. A significantly greater number of flocks of geese altered direction when leaving the area of the active sound simulator (after being lured to the area by decoys) than did flocks when the sound simulator was inactive. A float plane that landed on a lake adjacent to the simulator site caused all geese to leave the area. The authors recommended 1) that gas compressor stations be located in areas where they are likely to cause the least possible disruption of the activity patterns of geese; 2) that if optimum goose areas cannot be avoided when building the compressor stations, then the stations should be shut down during the snow goose staging period, or an efficient muffler system should be installed to reduce the area affected by the noise; and 3) that aircraft operations to the stations be kept to a minimum or suspended entirely during the snow goose staging period.

Activity: transport of oil/gas/water-land; transport of personnel/-equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Gollop, M.A., J.E. Black, B.E. Felske, and R.A. Davis. 1974. Disturbance studies of breeding black brant, common eiders, glaucous gulls, and arctic terns at Nunaluk Spit and Phillips Bay, Yukon Territory, July, 1972. Pages 153-201 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chapter 4. (UAF)*

The purpose of this field study, conducted in June and July 1972, at Nunaluk Spit and Phillips Bay, Yukon Territory, Canada, was to determine the effects of helicopters and fixed-wing aircraft and human disturbance on the reproductive success and behavior of breeding black brant, common eiders, glaucous gulls, and arctic terns. The habitat used by breeding and nonbreeding birds was a sparsely vegetated offshore barrier island formation associated with the Firth and Malcolm river deltas, similar to barrier island formations found along coastal Alaska. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment for black brant, glaucous gulls, and arctic terns. The activity of human disturbance produced documented direct impacts of active and passive harassment for all species studied. Conclusive results showed that helicopters produced a greater reaction from incubating birds than did fixed-wing aircraft, except for incubating common eiders, which showed no obvious response to either type of aircraft. Incubating gulls were the most sensitive to human disturbance, with eiders the least sensitive. The responses of arctic terns to human disturbance were not recorded. Nonincubating birds showed greater intolerance to disturbance than did incubating birds. Recommendations included 1) that helicopters stay above 460 m (1,500 ft) when flying over colonies of nesting common eiders, black brant, glaucous gulls, and arctic terns; 2) that fixed-wing aircraft stay above 150 m (500 ft) when flying over such colonies; 3) that flights over colonies at any altitude during the breeding season by kept at an absolute minimum to reduce the possibility of lowering tolerance levels through repeated exposure to passive or active harassment; and 4) that under no circumstances should any person be allowed to visit islands during the period in which they are being used by nesting sea birds.

Activity: human disturbance; transport of personnel/equipment/material -air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Hamilton, G.A., and P.I. Stanley. 1975. Further cases of poisoning of wild geese by an organophosphorus winter wheat seed treatment. Wildfowl 26:49-54.

This paper reports field observations of greylag (Anser anser) and pink-footed (Anser brachyrhynchus) geese that died from organophosphorus poisoning in November 1974 and January 1975 in Scotland. Ages or sex of the dead geese were not reported. Habitat types, other than winter wheat fields, were not described. Although greylag and pink-footed geese are not found in Alaska, they are congeneric with some geese found in Alaska, and the effects of pesticides on geese in Alaska are likely to be quite similar to those recorded in Scotland. The activities of grading and plowing and chemical application produced documented direct impacts of attraction to an artificial food source and mortality due to ingestion of chemicals. Ingestion of carbophenothion-treated winter wheat seed and germinating seed in newly planted wheatfields caused the death of about 400-500 greylag geese and about 250 pink-footed geese.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Hampton, P.D., and M.R. Joyce. 1985. Lisburne development environmental studies: 1984. Birds. Final rept. Chap. 2, Vol. 2:Caribou, birds, and oceanography. Prepared for ARCO Alaska, Inc., Anchorage, by Woodward-Clyde Consultants, Anchorage, and Entrix, Inc., Anchorage. (ADF&G-F, Habitat)*

This paper reports the results of field studies conducted during the summer of 1984 at Prudhoe Bay, Alaska, that investigated aspects of the nesting, brood-rearing, molting, and staging life history events for several species of birds. Brant, snow geese, white-fronted geese, and Canada geese were the primary species studied, although information on loons, gulls, ducks, and tundra swans was also gathered. Habitat within the study area was coastal tundra, coastal marsh, and river delta, interspersed with oilfield roads, pads, pipelines, and facilities. The activity of transporting personnel/equipment/material by land produced documented direct impacts of passive harassment and barriers to movement. A group of snow gesse (8 adults and 15 young) that encountered a road while walking toward a coastal marsh made three unsuccessful attempts to cross the road before succeeding on the fourth attempt. On each unsuccessful attempt, the geese were driven back from the area of the road by a passing truck. The activities of transporting personnel/equipment/material by water and human disturbance produced a documented direct impact of passive harrassment. Brant (no numbers given) feeding at a coastal marsh near the mouth of a river in late July ran to the river and swam upstream 2 km (1.2 mi) while maintaining an alert posture after an outboard motor boat entered the mouth of the river (the initial distance between the brant and the boat was not reported). Humans walking in the vicinity (no distances provided) of snow geese in late July caused prolonged harassment of geese on at least 2 d. The mean session length of behaviors, the average amount of time spent in behaviors, and the total estimated energy expenditure indicated that snow geese and brant within the study area were not significantly disturbed under the conditions present during the study. Observations also indicated accommodation to disturbance over time by brant and snow geese.

Activity: human disturbance; transport of personnel/equipment/material - land; transport of personnel/equipment/material-water.

Impact: barriers to movement, physical and behavioral; harassment, active (hazing, chasing) or passive (noise, scent).

Hanson, W.C., and L.L. Eberhardt. 1971. A Columbia River Canada goose population, 1950-1970. Wildl. Monogr. No. 28. (UAF)

This paper summarizes population studies of the western Canada goose that were conducted between 1950 and 1970 along the Columbia River on the Hanford Atomic Energy Commission Reservation in southeastern Washington. Intensive nesting studies were conducted each year during April and May; limited information was collected during the remaining months of each year. Vegetation of the region was dominated by bunchgrass and sagebrush. Geese nested primarily on annually inundated vegetated islands within the river and occasionally on clay and sandy loam bluffs along the river. Although vegetation types of this study area are not comparable to Alaskan situations, the physiographic structures (i.e., islands and bluffs) used by geese are similar to those used by geese in Alaska, and impacts to geese in these situations could be expected to be similar. The activities of human disturbance and water regulation/withdrawal/irrigation produced documented direct impacts of harassment and water level fluctuations. Visitation of nesting islands by humans led to desertion and destruction of nests, through robbing of eggs from nests, breaking eggs, photographing birds, and general human presence near nests. Regulation of water levels on the Columbia River (by regulating flows through several dams on the river) inundated several nests within the study area on at least two occasions. Potential impacts that were proposed to occur if a proposed dam was to be built within the study area included inundation of a major portion of the nesting islands and loss of brood-rearing areas. A proposal to channelize the river (in the event that the dam was not built) could allow coyotes increased access to nesting islands and subsequent increased losses of geese and nests, and disposal of dredge spoil along the riverbank would eliminate brood-rearing and resting habitat used by geese and other wildlife.

Activity: human disturbance; water regulation/withdrawal/irrigation.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); water level or water quality fluctuations.

Hogan, M. 1982. Disturbance studies of molting brant at East Long Lake National Petroleum Reserve, Alaska. Unpubl. USFWS, Anchorage, AK. (ADF&G-A, Habitat)#

Observations of molting brant (Branta bernicla nigricans) were made from blinds at East Long Lake from 19 July through 4 August 1980. The reaction of brant to aircraft and other types of disturbances were recorded incidentally to time/activity budgets of molting brant. A rating system was devised so that factors other than escape reaction were considered when assessing and comparing the impacts of disturbances. Factors considered were 1) reaction behavior, 2) percentage of the flock reacting, 3) habitat zones crossed (distance moved), 4) percentage of the flock returning, and 5) the duration of the response.

Seventy disturbances were recorded during 198 hours of observation. Aircraft accounted for 78.6% of recorded disturbances (55.7% fixed wing, 22.9% helicopter); 15.7% were reactions to unknown causes; 2.9% were from gunshots; and 1.4% each were caused by arctic fox (Alopex lagopus) and caribou (Rangifer tarandus). Distances between the birds and the source of the disturbance were not reported. When disturbed, birds usually entered the lake (44.3%) or moved to the peat mud zone (21.4%) closest to open water. The sum of all response duration periods was 357 min, which meant that brant were disrupted 3% of all observed time. Mean duration of all responses was 5.1 min. Mean duration of responses to aircraft was 4.4 min, with no significant difference between fixed-wing and helicopter disturbances. Birds appeared to become more sensitive to successive disturbances when disturbances were closely spaced.

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Jones, R.D., and G.V. Byrd. 1979. Interrelations between seabirds and introduced animals. Pages 221-226 in J.C. Bartonek and D.N. Nettleship, eds. Conservation of marine birds of northern North America. USFWS Wildl. Res. Rept. 11. (UAF)

The purpose of this review paper was to discuss the effects of introduced animals on seabirds and their nesting habitat on islands, with emphasis on islands off the coasts of Washington, British Columbia, and Alaska. References discussed included papers dating to 1831, although quantitative data were confined to the 1970's. Seabirds, when specific species were mentioned, included shearwaters, puffins, auklets, petrels, and murrelets. The effects of introduced species on the Aleutian Canada goose were also discussed. The activities of grazing (furfarming) and transporting personnel/equipment/material by air and water produced a documented direct impact of increased susceptibility to predation. Documented indirect impacts associated with the above activities were vegetation damage/destruction due to grazing by introduced domestic animals and terrain destruction and alteration. A potential impact discussed was the increased susceptibility of seabirds and geese in the Aleutian Islands to parasitism by a blood parasite carried by introduced black flies. Conclusive results were that foxes introduced to the Aleutian Islands eliminated the Aleutian Canada goose from all but one of its nesting islands. Introduced rats were found to prey on young seabirds on some New Zealand islands. Introduced rats are also present on some islands in the Aleutian chain, but the effects of these introductions have not been documented. Introduced sheep on an island in Washington were reported to have grazed and trampled nesting areas of burrowing seabirds. Landslides initiated by these activities buried burrows and rendered the slopes unusable by burrowing seabirds.

Activity: grazing; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: pasasitism and predation, increased susceptibility to.

Kahl, R.B., and F.B. Samson. 1984. Factors affecting yield of winter wheat grazed by geese. Wildl. Soc. Bull. 12:256-262. (UAF)

This paper reports the results of field studies that determined the extent and timing of grazing of winter wheat by wild Canada geese in central Missouri from late September to mid April 1977-1978 and 1978-1979 and investigated the effects of grazing by captive Canada geese on spring growth, forage production, and grain yields of winter wheat. Ages or sex of wild geese observed or of captive geese used in grazing trials were not reported. Habitat types, other than cornfields, wheatfields, and grasslands used by geese, were not described. Although winter wheat is not extensively grown in Alaska at present, further development of agriculture in Alaska, particularly of cereal crops (including wheat), could create situations where geese are attracted to fields and feed on crops. The activity of grading and plowing produced a documented direct impact of attraction to an artificial food source. Damage to wheat by grazing geese arose through removal of foliage under certain environmental conditions (poor growing conditions and harsh winter weather) and at specific stages of growth and indirectly through trampling. Young wheat in fall and winter with minimal nutrient reserves and jointing plants in spring with growing points above ground were most vulnerable to grazing by geese.

Activity: grading/plowing.

Impact: attraction to artificial food source.

Kiera, E.F.W. 1979. Feeding ecology of black brant on the North Slope of Alaska. M.S. Thesis, Western Washington Univ. 50 pp. (ADF&G-A, Habitat)#

This study investigated the feeding ecology of black brant in their summer habitats from June to September 1978, the demand made by migrating brant on the vegetation of arctic salt marshes, the carrying capacity of these marshes, and the effects of human disturbance on brant.

In years previous to the study, the colony of brant nesting on Anachlik Island remained in the nesting area during molt. During the study, however, they left the island as soon as the young were hatched and dry, and they did not return for the remainder of the season. This was presumably due to the presence of the investigator.

In mid June, when the nonbreeding brant were in a salt marsh in the Colville River delta, the investigator went into the area once to build a blind. As a result, the brant left the area, and the presence of the investigator, along with the tent and blind, was apparently sufficient disturbance to prevent their return.

At Prudhoe Bay, feeding brant were not disturbed by trucks on the road (several hundred meters away) or by airplanes flying above 500 m (1,650 ft), but passing helicopters caused them to fly. Usually they returned to feed as soon as the helicopter passed.

One conclusion that was reached for at least the Prudhoe Bay area was that if brant are using salt marshes at near carrying capacity, and thus food is limited, brant may be being forced to tolerate increased disturbance.

Activity: human disturbance; transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Klebesadel, L.J., and S.H. Restad. 1981. Agriculture and wildlife: are they compatible in Alaska? Agroborealis 13:15-22. (UAF)*

In this review article, the interactions between agriculture and wildlife, including bighorn sheep, bison, brown bear, caribou, eagle, moose, mule deer, waterfowl, and the furbearers coyote, fox, lynx, marten, and wolverine, of all life stages in Alaska and in the northern tier of the continguous 48 states are discussed. Papers cited were published between 1950 and 1980 and include studies done in a variety of seasons and years. With the exception of bighorn sheep, similar to Dall sheep, and mule deer, closely related to Sitka black-tailed deer, the species are the same as those that occur in Alaska. Although the habitat types in the northern tier states are not strictly comparable to those in Alaska, the overall impacts of agriculture are expected to be similar. The activities of clearing, grading/plowing, and grazing were responsible for the documented direct impacts of attraction to an artificial food source and change in harvest level, and the indirect impacts of competition with introduced domestic species, vegetation composition change, and vegetation damage or destruction due to mechanical removal. In Wisconsin, the disappearance of caribou and of furbearers, including lynx, marten, and wolverine during white settlement, are attributed to overharvest and in some cases habitat destruction. In the contiguous 48 states, conclusive results show that bighorn sheep and mule deer compete with domestic livestock for forage and that fox and coyote are attracted to the artificial food sources of poultry and lambs, respectively. On islands of southwest Alaska, eagles and foxes are also attracted to newborn domestic lambs. Bison are attracted in the late summer to the barley fields in their range near Delta Junction, as are waterfowl. The latter are also attracted to other small-grain growing areas in Alaska, in spring and also in fall. Domestic cattle attract brown bears, which kill or injure them on Kodiak Island. Fires during railroad construction in the Matanuska-Susitna Valley and subsequent clearing of small farms resulted in increased browse for moose in burns and on the periphery of farms, and vegetation destruction on the active farms. Management recommendations include the following: 1) provide alternate food sources for predators at the lambing time of domestic sheep and 2) plant large acreages of grain as lure crops for waterfowl during fall migrations.

Activity: grading/plowing.

Impact: attraction to artificial food source.

Lehnhausen, W.A., and S.E. Quinlan. 1981. Bird migration and habitat use at Icy Cape, Alaska. Unpubl. Mss. USFWS, Anchorage, AK. 298 pp. (ADF&G-F, Habitat)*

This reference reports the results of field studies conducted May through September 1980 on the use of the Icy Cape area of northwestern Alaska by wildlife. A major component of the studies involved quantifying bird migration past Icy Cape and local use of the area by birds. The Icy Cape area is part of an extensive barrier island/lagoon system (Kasegaluk Lagoon). Habitat within the area includes sparsely vegetated barrier islands, a shallow lagoon, salt marsh, tundra, and freshwater wetlands. The activities of transporting personnel/equipment/material by air and human disturbance produced a documented direct impact of harassment. Aircraft flying at altitudes of 15-60 m (50-200 ft) over the barrier islands and the lagoon disturbed nesting, feeding, and resting birds. Common eiders flushed off their nests in mass panic flights when overflown by aircraft at low altitudes. Molting oldsquaws frequently moved from shore or dove as aircraft passed overhead. Glaucous gulls, arctic terns, and black brant flushed from the lagoon or from the barrier islands when overflown by aircraft at low altitudes. During fall migration, flocks of 100-500 black brant on salt marsh areas flushed when humans on the ground were 3-4 km (1.9-2.5 mi) away. Researchers conducting bird surveys also caused nesting birds to flush from their nests. The authors recommended that human activity on the barrier islands be restricted between 15 June and 15 September to protect nesting and molting birds. Several recommendations regarding the prohibition or restriction of development activities (e.g., oil and gas exploration and development, gravel sources, staging areas) were proposed for the barrier island/lagoon systems/nearshore waters. These recommendations were based on perceived potential impacts to the birds of the area and their habitat.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

MacInnes, C.D., and R.J. Misra. 1972. Predation on Canada goose nests at McConnell River, Northwest Territories. J. Wildl. Manage. 36(2):414-422. (UAF)

This field study was conducted during the summers of 1965-1969 at McConnell River, Northwest Territories, Canada. The purpose of the study was to estimate the loss of Canada goose eggs to predators. The habitat type within the study area was arctic tundra. This area is similar in habitat and conditions found in portions of Canada goose habitat in Alaska. The activity of human disturbance produced documented direct impacts of active harassment and increased susceptibility to predation. Conclusive results indicated that during the 5-yr study, 22% of the eggs laid were lost to predators. Fifty-five percent of these losses were directly attributed to repeated visits to the nests by researchers. Jaegers and gulls were frequently observed eating eggs from nests from which the female goose had been flushed by humans. The authors concluded that the predation losses of eggs without human disturbance would have been approximately 10% of the eggs laid. Arctic foxes were not common to the study area during the study period.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

McCabe, T.R. 1979. Productivity and nesting habitat of Great Basin Canada geese, Umatilla, Oregon. Pages 117-129 in R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific flyway geese: a symposium. OSU Book Stores, Inc., Corvallis. (UAF)

This field study was conducted during 1974 and 1975 along the Columbia River in Washington and Oregon. The purpose of the study was to document the breeding habitat used and the productivity of resident Canada geese in relation to hydroelectric impoundments on the Columbia River. Shrub-steppe, characterized by sagebrush and grasses, was the habitat type found in the study area. This study is applicable to Alaska, as it provides information on a species found in Alaska and provides documented effects of hydroelectric projects on geese. The activities of water regulation/withdrawal/irrigation and human disturbance produced documented direct impacts of passive harassment, water level fluctuation, and terrain alteration and destruction. Increased public use of nesting islands in 1975 was reported as one factor influencing decreased nesting success, although the effects were not quantified. Fluctuations in water level due to water regulation at upstream dams was reported to have reduced available nesting habitat through periodic flooding and made nesting islands more susceptible to wind and wave erosion. A potential situation proposed was the complete erosion and loss of nesting islands to wave and wind action.

Activity: human disturbance; water regulation/withdrawal/irrigation.

Impact: harassment, active (hazing, chasing) or passive (noise, scent; terrain alteration or destruction (e.g., cliffs); water level or water quality flucuations.

Mickelson, P.G. 1975. Breeding biology of cackling geese and associated species on the Yukon-Kuskokwim Delta, Alaska. Wildl. Monogr. No. 45. (UAF)

This paper reports the results of field studies conducted May through September 1969-1972 on the Yukon-Kuskokwim delta that examined the breeding biology of cackling Canada geese, black brant, emperor geese, white-fronted geese, and spectacled eiders. Habitat within the study area was wet meadow interspersed with numerous tidal sloughs and shallow ponds. The activities of human disturbance and transport of personnel/equipment/material by water produced documented direct impacts of harassment and increased susceptibility to predation. Conclusive results indicated that about half of all losses of goose and eider eggs and young were the result of human-induced predation. Parasitic jaegers and glaucous gulls preyed on eggs in nests from which females were flushed by humans and on goslings that were separated from their parents. Humans on foot, in addition to increasing rates of predation on eggs and young, also caused desertion of nests, the result of repeated nest-site visits during the early egg-laying period. Boat traffic on sloughs or rivers also caused separation of young and adults and increased rates of predation on young by gulls and jaegers.

Activity: human disturbance; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Nieman, D.J., and H.J. Dirschl. 1973. Waterfowl populations on the Peace-Athabasca delta, 1969 and 1970. Can. Wildl. Serv. Occas. Pap. No. 17. (UAF)

This paper reports the results of field studies conducted spring through fall 1969 and 1970 that investigated the habitat preferences and requirements of waterfowl, primarily ducks, during the breeding, molting, and fall staging periods in the Peace-Athabasca delta in northeast Alberta, Canada. The Peace-Athabasca delta is an extensive marsh complex containing extensive muddy lowlands, marshes, shallow ponds and lakes, and meandering streams. Dabbling and diving ducks make extensive use of the area for breeding, molting, and staging. Geese (Canada, snow, and white-fronted geese) make use of the delta primarily during the fall staging period. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of terrain alteration or destruction, water level fluctuations, and changes in sucessional stages of vegetation preferred by waterfowl. Completion and filling of the Bennett Dam reservoir on the Peace River in spring 1968 led to a decreased flow of water to the Peace-Athabasca delta and a decline in water levels throughout much of the delta. Conclusive results indicated a permanent drying of shallow basins, with subsequent changes in patterns of vegetation and use by ducks and geese. Areas formerly preferred by ducks and geese for breeding, molting, and staging received decreased use or were abandoned as water levels declined and preferred habitat deteriorated.

Activity: water regulation/withdrawal/irrigation.

Impact: terrain alteration or destruction (e.g., cliffs); water level or water quality flucuations.

Owens, N.W. 1977. Responses of wintering Brent geese to human disturbance. Wildfowl 28:5-14. (UAF)#

This paper describes the effects of human disturbance on dark-bellied Brent geese (Branta bernicla bernicla) wintering in Essex in 1973-1974 and 1974-1975 in terms of a) the restrictions of feeding area and b) the effects on feeding behavior and flighting.

Brent geese were particularly susceptible to disturbance by aircraft, and any plane below about 500 m (450 ft) and up to 1.5 km (0.9 mi) away could put them to flight. Slow, noisy aircraft were especially harmful, and helicopters caused widespread panic. The geese were very slow to habituate to aircraft, although in January-February they did cease responding to the transport planes that took off regularly from Southend Airport. Other low-flying aircraft continued to cause disturbance throughout the winter.

Large boats rarely caused disturbance, being generally in deep water. Even when they did come close, the birds ignored them. Yachts rarely disturbed Brent geese, but small boats with noisy outboard engines caused them to take flight.

When disturbances occurred very frequently, birds appeared to become more easily disturbed on subsequent occasions. For example, three people walking on the Zostera beds, at Leigh in November approached Brent geese three times in the space of 1 hr. At the first approach, the birds flew up, when the people were about 200 m (650 ft) away, at the second approach 600 m, (2,000 ft), and on the third at 800 m (2,600 ft).

Activity: human disturbance; transport of personnel/equipment/material -air; transport of personnel/equipment/material-water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Renken, R., M. North, and S.G. Simpson. 1983. Waterbird studies on the Colville River delta, Alaska: 1983 summary report. Draft. USFWS, Anchorage. (ADF&G-F, Habitat)

This paper reports general observations of waterbirds gathered incidentally during intensive field studies of swans, geese, and loons on the Colville River delta, Alaska, during May through August 1983. Observations included weather conditions, bird migration and nesting phenology, brant migration and nesting success, mammal activity, and aircraft overflights. Habitat within the study area is a combination of coastal tundra, lakes, and river delta. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Except during sensitive periods (arrival, molt, staging), most birds did not seem to be disturbed by aircraft at altitudes greater than 100 m (328 ft). On three occasions [dates not provided] when single-engine aircraft flew overhead at 30-40 m (100-130 ft), a pair of tundra swans and 15 geese [species not specified] and other birds were flushed. On 9 August, when geese were staging in flocks, a helicopter at an altitude of 150 m (500 ft) and 1 km (0.6 mi) distant flushed all 130 white-fronted geese and half of the 29 Canada geese that were feeding and roosting in a tapped lake basin. Nearly all geese circled and returned to the site within 10 min. Pintails and mallards at the same site reacted only with alert postures.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Salter, R., and R.A. Davis. 1974. Snow geese disturbance by aircraft on the North Slope, September, 1972. Pages 258-279 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 6. (UAF)*

This field study, conducted September 3 and 4, 1972, was designed to assess the reaction of snow geese to overflights by light aircraft at varying altitudes and to determine whether snow geese could be driven from an area by hazing with an aircraft (a Cessna 185 in both instances). The study was conducted along the Beaufort Sea coast near the Jago River, Alaska, and near Komakuk Beach, Yukon Territory, Canada. Habitat within the study area was coastal tundra. Snow geese flocks that were studied were staging and feeding during their early stages of fall southward migration. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Conclusive results showed that flocks of snow geese flushed in response to approach and overflights by a Cessna 185 at altitudes ranging from 91 to 3,050 m (300 to 10,000 ft) and at distances from 1.6 to 14.6 km (1 to 9 mi). Numbers of snow geese in each flock ranged from 50 to 4,000 geese. Hazing of 2,400 geese by the aircraft at an altitude of 305 m (1,000 ft) caused the geese to vacate an area of approximately 130 km^2 (50 mi^2) within 15 min and caused a reduction in the sizes of flocks with consequent increase in the number of flocks. The authors recommended that operation of aircraft over the premigratory staging areas between August 15 and September 30 be avoided and that necessary overflights during this time should avoid areas of heavy snow goose concentration.

[Reviewer's note: The distances that the geese were from the aircraft when they flushed were estimated by an observer from within the aircraft. The possibility of substantial error in accurately estimating distances, particularly at altitudes above 1,525 m (5,000 ft) over terrain with relatively few landmarks, should be recognized.]

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sellers, R. 1979. Waterbird use of and management considerations for Cook Inlet state game refuges. Draft report. ADF&G, Anchorage. 42pp. (HD).

This field study conducted during the summer of 1978 had several objectives including documentation of the response of waterfowl to aircraft operation, documentation of waterfowl production and habitat use and assessment of public opinion on use and management of refuge lands. The study area in southcentral Alaska contained three coastal marshes - Susitna Flats, Palmer Hay Flats and Goose Bay. Ducks and geese were the primary species studied, although shorebird and other bird activity was recorded. The activity of transport of personnel/equipment/material by air produced documented direct impacts of active and passive harassment. Tentative conclusions reached by the author were that, 1) geese were generally more subject to disturbance than ducks, 2) that helicopters produced a greater reaction from waterfowl than did planes flying at the same altitude, 3) that waterfowl, particularly ducks, can become habituated to aircraft flying above 400 ft provided there is not a direct association with subsequent active harassment. Aircraft use on the Palmer Hay Flats has been implicated in changes in activity patterns of and premature southward migration of fall staging lesser Canada geese.

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Slaney, F.F., and Co. 1973. Environmental effects assessment, Voyageur air cushion vehicle, Mackenzie Delta, N.W.T. Vol. II:Field Studies. Environmental Protection Service, Environment Canada. (UAF)

This field study was conducted during February, March, and August 1973 to assess the effects of a large air cushion vehicle (ACV) on the vegetation and wildlife of the Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, Canada. Reactions of tundra swans, black brant, white-fronted geese, greater scaup, and dabbling ducks to the ACV during August 1973 were recorded. Habitat within the study area was coastal tundra. The activity of transporting personnel/equipment/material by land produced documented direct impacts of harassment and collision with vehicles. Tundra swans flushed an average of 430 m (1,400 ft) [n = 17, range 69-823 m (225-2,700 ft)] ahead of the ACV. Larger groups tended to flush at greater distances than did solitary birds. A flock of 70 black brant became less tolerant of the ACV during repeated passes and increased their flushing distance from 225 m (725 ft) on the first pass to 1,190 m (3,900 ft) by the third pass. Brant displayed alertness to the sound of the ACV when the machine was out of sight and from 1.2-1.6 km (3/4-1 mi) distant. White-fronted geese flushed an average of 225 m (725 ft) [n = 5, range 91-550 m (300-1,800 ft)] from the ACV, with larger flocks generally flushing at greater distances. Dabbling ducks were relatively tolerant of the ACV, flushing an average of 83 m (270 ft) [n = 6, range 23-228 m (75-750 ft)] from the machine. One molting mallard was overrun on three occasions by the ACV with no apparent harmful effects. Greater scaup were relatively intolerant of the ACV, flushing at distances of 730 m (2,400 ft) and 1,200 m (3,900 ft). The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. White-fronted geese, Canada geese, and dabbling ducks flushed in response to aircraft overflights at distances ranging from 60 m to 1,980 m (200 ft to 6,500 ft).

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/-equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: drilling; human disturbance; transport of oil/gas/water - land; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water; water regulation/withdrawal/irrigation.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to; water level or water quality fluctuations.

Spindler, M.A. 1984. Distribution, abundance, and productivity of fall staging lesser snow geese in coastal habitats of northeast Alaska and northwest Canada, 1983. Pages 74-101 in G.W. Garner and P.E. Reynolds, eds. 1983 update report: baseline study of the fish, wildlife, and their habitats. Arctic National Wildlife Refuge Coastal Plain Resource Assessment. ANWR Progress Rept. No. FY84-2. USDI:USFWS, Anchorage, AK. February 1984. (UAF)*

This field study conducted from late August to late September 1983 examined the spatial and temporal distribution, abundance, productivity, habitat use, and responses to aircraft overflights of lesser snow geese staging in northeastern Alaska and northwestern Canada prior to their southward fall migration. Data are presented for geese observed from Banks Island and the Bathurst Peninsula in the Northwest Territories, Canada, westward to the Sadlerochit River within the Arctic National Wildlife Refuge in Alaska. Habitat within the study area included coastal tundra, river valleys and deltas, and the northern foothills of the Brooks Range and British Mountains. The activities of transporting personnel/equipment/material by air and human disturbance produced documented direct impacts of active and passive harassment. Overflights by fixed-winged aircraft at altitudes of up to 3,000 m (9,800 ft) caused snow geese to take flight. Low altitude (less than 30 m [100 ft]) aircraft overflights produced less disturbance to geese than did flights at higher altitudes, possibly due to reduced lateral dispersion of sound. Snow geese reacted (flushed) to aircraft at distances up to 10 km (6.2 mi). An evening overflight at 150 m (500 ft) caused all geese (2,441) within a 4 km (2.5 mi) radius to take flight, 70% of which left the area. Total numbers of geese present the following morning were comparable to numbers recorded the previous morning. The results of the snow goose-aircraft disturbance study conducted by Davis and Wiseley (1974) were also summarized in this paper. Intentional stalking of a small flock of snow geese by a human caused the flock to take flight at 150 m (500 ft) and land 2 km (1.2 mi) away.

Activity: human disturbance; transport of personnel/equipment/material -air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sterling, T., and A. Dzubin. 1967. Canada goose molt migrations to the Northwest Territories. Trans. N. Am. Wildl. Nat. Resour. Conf. 32:355-373. (UAF)

This paper reports observations on the molt migration of Canada geese from mid-continent North America to the lake-studded tundra and open boreal forest regions along the Back and Thelon rivers of the eastern Northwest Territories. Observations of geese were conducted June through August 1963-1966. Primarily nonbreeding or unsuccessful breeding adult or sub-adult geese used the molting areas. The activity of human disturbance produced a documented direct impact of harassment. Banding drives of molting geese over three successive years caused almost complete abandonment of one traditional molting site. Banding drives at another site caused geese to leave the water and move 5 km (3 mi) inland.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Stout, I.J., and G.W. Cornwell. 1976. Nonhunting mortality of fledged North American waterfowl. J. Wildl. Manage. 40(4):681-693. (UAF)

This review paper summarizes the reported nonhunting mortality of wild waterfowl for North America for the period 1930-1964, based on data from the open literature, unpublished federal reports, a questionaire, and band recoveries. Data were summarized on mortality from collisions, weather, predation, pollution, diseases, poisons, and miscellaneous factors. Data were compiled for dabbling ducks, diving ducks, geese, and swans. The activities of transporting personnel/equipment/material by air and land produced a documented direct impact of collision with vehicles or electrocution by powerlines. Collision mortality (n = 3,015 for all waterfowl combined) was 0.1% of the total sample (n = 2,108,880). Collisions with utility wires and automobiles were the most frequent causes of mortality. The activities of transporting oil by water, processing oil/gas, processing minerals, and chemical application produced a documented direct impact of mortality due to contact with or ingestion of petroleum, petroleum products, or chemicals. Mortality from pollution (n = 13,944) was 0.6% of the total sample and involved primarily oil-contaminated diving ducks. Various chemicals and detergents were reported to have killed waterfowl, particularly in the Central Flyway where pollution from mines was prevalent. Losses of waterfowl to pesticides were also reported. The activity of netting produced a documented direct impact of entanglement in fishing nets. Approximately 51,000 waterfowl, primarily diving ducks, drowned in fishing nets. Mortality from various avian diseases was the greatest component (87.7% or 1,873,970 birds) of the total reported mortality.

Activity: chemical application; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; morbidity or mortality due to ingestion of or contact with petroleum.

Sugden, L.G. 1976. Waterfowl damage to Canadian grain: current problems and research needs. Can. Wildl. Serv. Occas. Paper No. 24. 25 pp. (UAF)*

This excellent review paper examined the problem of attraction of waterfowl to grain fields and the subsequent damage to unharvested grain by feeding waterfowl in the Canadian provinces of Alberta, Manitoba, and Saskatchewan. Papers reviewed were from the 1940's through the 1970's and primarily discussed waterfowl/farming problems in the Canadian prairie provinces and the prairie lands of the northcentral United States. Although the habitat types in these areas are not strictly comparable to those in Alaska, similar conflicts may occur with increased development of grain farming in Alaska. Age, sex, or species-specific information concerning waterfowl was not presented in this paper. The activity of grading and plowing produced a documented direct impact of attraction to an artificial food source. The activities of human disturbance and transporting personnel/equipment/-material by air produced a documented direct impact of harassment. Ducks and geese are attracted to fields of grain in autumn and damage unharvested grain when it is eaten, trampled, and fouled. Crop damage became prevalent in the 1940's, when the practice of allowing grain to ripen in swaths before threshing was initiated. Mallards, which tend to remain later in autumn, are more abundant, and have a greater tendency to field feed, caused the most damage, which was sustained primarily by barley and wheat. Damage to grain by geese tends to be less extensive but more localized. Grain fields near large wetlands tend to attract more ducks and receive greater damage. Various techniques of scaring waterfowl from fields and their relative effectiveness were discussed. Techniques included hazing with aircraft, shooting, and a variety of devices used to generate noise that would frighten waterfowl. Other topics discussed included the extent of damage and the costs to grain farmers, the use of lure crops to keep waterfowl from farm fields, and payment (compensation) programs for grain damage. Suggested practices that might reduce damage to grain included growing nonsusceptible crops (flaxseed or rapeseed), growing grain varieties that can be harvested earlier or without using swaths, using shatter-resistant varieties, leaving high stubble to discourage ducks, delaying cultivation of harvested fields until nearby susceptible crops have been harvested (which allows ducks to feed on waste grain in a place where they can do no damage), and putting areas of marginal farmlands that suffer chronic damage to other uses such as for lure crops or recreation.

Activity: grading/plowing; human disturbance; transport of personnel/-equipment/material - air.

Impact: attraction to artificial food source; harassment, active (hazing, chasing) or passive (noise, scent).

Timm, D. 1980. Annual report of survey and inventory activities, waterfowl, 1979-1980. ADF&G Fed. Aid Wildl. Rest. Proj. prog. rept. Vol. 11. Proj. W-19-1, Job 10.0. Juneau. 35 pp. (ADF&G-F)*

This field study was initiated in 1979 to evaluate the possibility that aircraft disturbance affects goose use of the Pilot Point and Cinder River critical habitat areas on the Alaska Peninsula. Emperor and cackling Canada geese were observed during October 1979. Coastal marsh was the habitat type used by the geese. The activity of transporting personnel/equipment/-material by air produced the documented direct impact of passive harassment. Reactions of emperor geese (up to 3,000 geese) at Cinder River to low-flying aircraft varied, ranging from brief flights, with all or most geese returning to their original location after a few seconds of flying, to movement to a new area up to several miles away. On two occasions when an aircraft flew over the center of the bay at an altitude of 60-90 m (200-300 ft), all geese flushed, including those over a mile away from the aircraft. A flock of 450 cackling Canada geese at Pilot Point flew around for about 30 seconds before landing in the original spot after being flushed twice by planes 0.8 km (0.5 mi) away. Closer overflights by aircraft caused the flock to move approximately 3.2 km (2 mi) to another favored area.

Activity: transport of personnel/equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Troy, D.M. 1985. Prudhoe Bay Waterflood project environmental monitoring program terrestrial studies, 1984. Draft rept. Prepared for Envirosphere Company by LGL Alaska Research Associates, Inc., Anchorage, AK. 126 pp. (ADF&G-F, Habitat)

This field research report details the results of studies conducted during the summer of 1984, with integration of work conducted during the summers of 1981-1983, that examined the effects of the Prudhoe Bay Waterflood project's West Road and its associated facilities on the surrounding vegetation and bird life. Tundra bird studies were directed at evaluating habitat use by birds, evaluating the effects of traffic on the West Road and related disturbance on birds, and evaluating the effects of habitat alterations such as impoundments on birds. The studies were conducted in the vicinity of the Prudhoe Bay West Dock and Pt. McIntyre, Alaska. Habitat within the study are is coastal tundra. Species studied included Canada, snow, and white-fronted geese, eiders, oldsquaw, dabbling ducks, tundra swans, loons, shorebirds, and songbirds. Breeding and nonbreeding birds [and presumably young-of-the-year after hatching] were studied from June through September. The activity of aquatic (wetlands) filling produced a documented direct impact of water impoundment. Conclusive results showed that the West Road blocked or impeded sheet flow of water, creating impoundments that effectively eliminated or reduced habitat quality during the breeding season for white-fronted geese and king eider.

Activity: filling and pile-supported structures (aquatic).

Impact: water level or water quality fluctuations.

USDI. 1976a. Final environmental impact statement. Pages 322-329 and 501-504 _in_ Alaska natural gas transportation system. Washington, D.C. (ARL)#

Studies on the effects of gas compressor noise simulations on wildlife determined that caribou, Dall sheep, and snow geese abandoned or reduced their use of areas within varying distances of compressor station simulators. The degree of avoidance by caribou varied with the season. All species also exhibited diverted movements to avoid the source of noise. Geese appeared especially sensitive. Geese forced to detour around compressor stations near staging areas may not be able to compensate for the increased energy expenditure and may consequently migrate with insufficient reserves.

Studies on impacts of aircraft disturbance on wildlife determined the following:

(1) Dall sheep reactions to aircraft were relatively severe, including panic running, temporary desertion and/or reduced use of traditional areas following activities involving aircraft and generator noise, and flight in response to aircraft at relatively high altitudes.

(2) Caribou, moose, grizzly bears, wolves, raptors, and waterfowl showed variable degrees of flight, interruption of activity, and panic. The degree of response was influenced by the aircraft's altitude, distance, and type of flight (e.g., low circling), group size, activity of animals, sex, season, and terrain.

(3) Muskoxen may have shifted their traditional summer range by 26 km (16 mi) in response to heavy helicopter traffic.

(4) Waterfowl, shorebirds, and Bald Eagles exhibited reduced nesting success and production of young, nest abandonment, and loss of eggs in response to aircraft disturbance, especially by helicopter. The addition of on-the-ground human disturbance may increase the severity of impacts.

(5) Muskoxen and Canada geese near airfields appeared habituated to aircraft. Waterfowl may adapt to float planes. Wolves apparently adapt regularly to aircraft noise if not subjected to aerial hunting.

Studies of impacts of blasting and drilling on wildlife determined the following:

(1) Dall sheep interrupted activities in response to blasting 5.6 km (3.5 mi) away, though their reactions decreased over time.

(2) Caribou can apparently tolerate winter blasting if they are not hunted.

(3) Peregrine falcons deserted nests in response to construction activity. However, falcons may accommodate to construction noise, except blasting, if it is not centered near the nest.

(4) Waterfowl with young avoid drilling rigs within a 4.3 km (2.6 mi) radius.

Activity: drilling; transport of oil/gas/water-land; transport of personnel/ equipment/material-air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Welling, C.H., and S.R. Johnson. 1982. Snow goose investigations. In Biological and archeological investigations in the vicinity of the proposed Duck Island Unit Pipeline through the Sagavanirktok River delta, Alaska. Unpubl. rept. by LGL Alaska Research Associates, Inc., Fairbanks, for Exxon Company, USA, Los Angeles. (ADF&G-F, Habitat)*

This field/review paper reported the results of aerial surveys and banding studies of snow geese conducted on the Sagavanirktok River delta near Prudhoe Bay, Alaska, during summer and fall 1981, and also reviewed some studies that documented impacts to breeding and fall staging snow geese from aircraft, drilling, and compressor simulators. Molting family groups of snow geese were studied in the Sagavanirktok River delta. Habitat within the area of the delta is coastal tundra. The activities of drilling, transporting personnel/equipment/material by air, and transporting oil/gas/water by land (simulated) produced a documented direct impact of harassment. Snow geese, in studies that were reviewed in this paper, responded to the above activities by avoiding areas near the site of the activity, altering patterns of feeding and flight behavior, and in one instance, apparently abandoning a nesting area. The authors recommended that 1) helicopter and fixed-wing aircraft avoid Howe and Duck islands (used by nesting snow geese in the Sagavanirktok River delta) by a minimum of 1.6 km (1 mi) between May 25 and July 7, 2) necessary overflights of Howe and Duck islands be conducted above 500 m (1,650 ft), and 3) hovercraft, Rollogon, and helicopter flight paths through the Sagavanirktok River delta between early July and mid August be routed to avoid flightless snow geese.

Activity: transport of oil/gas/water - land; transport of personnel/-equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

White, D.H., C.A. Mitchell, L.D. Wynn, E.L. Flickinger, and E.J. Kolbe. 1982. Organophosphate insecticide poisoning of Canada geese in the Texas panhandle. J. Field Ornithol. 53(1):22-27. (UAF)*

This paper reports the discovery of 1,600 dead waterfowl on 26 January 1981 at a playa lake in the Texas panhandle. The dead birds included approximately 1,480 Canada geese, 20 white-fronted geese, 75 mallards, and 25 pintails. No information on ages or sexes of the dead birds was provided. Conclusive laboratory analyses of tissues from a sample of the dead geese indicated poisoning by parathion and methyl parathion. Parathion and methyl parathion were also detected on winter wheat stems and leaves found in the digestive tracts of dead geese. Crop lands surrounding the playa lake were planted with winter wheat, and one field received an aerial application of parathion/methyl parathion 2 d prior to the death of the waterfowl. The authors recommended that less toxic materials, such as malathion, be used to control insects on grain crops when waterfowl are in the vicinity of treatment. Impacts of agricultural chemicals to waterfowl in Alaska could be expected to be similar to those found elsewhere if similar chemicals are used. The activities of chemical application and grading and plowing produced documented direct impacts of morbidity and mortality due to ingestion of chemicals and attraction to an artificial food source.

Activity: chemical application; grading/plowing.

Impact: attraction to artificial food source; morbidity or mortality due to ingestion of or contact with petroleum.

Wiseley, A.N. 1974. Disturbance to snow geese and other large waterfowl species by gas-compressor sound simulation, Komakuk, Yukon Territory, August-September, 1973. Pages 1-36 in W.W.H. Gunn, W.J. Richardson, R.E. Schweinsburg, and T.D. Wright, eds. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biol. Rept. Ser., Vol. 27. (UAF)*

This field study was conducted from August 25 to September 28, 1973, on the arctic coastal plain at Komakuk, Yukon Territory. Objectives of the study were to determine the responses of staging and migrating snow geese to the sounds of a gas compressor sound simulator and to determine if geese would accommodate to this disturbance and feed in areas adjacent to the simulators. Habitat within the study area was arctic coastal tundra. Data on sex and age composition of snow goose flocks were not provided; flocks likely contained adult, subadult, and juvenile birds in family groups and other associations. The activity of transporting oil/gas/water by land (simulated) produced a documented direct impact of harassment. Noise from the sound simulator caused geese to break their flight formations, flare, gain altitude, increase calling behavior, increase or decrease their speed flight, and to land. Geese that were both vertically and horizonally nearer to the simulators reacted to sound disturbance more frequently than birds farther away. With one exception, feeding flocks of geese approached no closer than 800 m (2,625 ft) to the operating simulator's north side (where the most intense sound was directed). Flocks of geese fed within 100 m (328 ft) of the simulator when it was turned off during control periods. Some limited accommodation by feeding flocks of snow geese to the area of sound as evidenced by a series of "leapfrog" movements by some feeding flocks that brought them from well away from the sound simulator to a position somewhat closer. White-fronted and Canada geese and whistling (tundra) swans reacted to the sound simulator in a fashion similar to that of snow geese.

[Reviewer's note: The results of this study are comparable to the results of another similar study conducted the previous year by Gollop and Davis (1974). Gollop and Davis (1974) reported that snow geese only approached to within 2.5 km (1.6 mi) of the sound simulator, whereas geese approached to 800 m (2,625 ft) in this study. The author speculated that the decoys used to lure geese to the area of the simulators in the previous study (Gollop and Davis 1974) may have caused the geese to be more wary, that differences in topography may have caused differences in dispersion of sound from the simulator, and that the short time span of the previous study may not have been sufficient to allow any accommodation by the geese, all of which individually or collectively may account for the differences of the results of the two studies.]

Activity: transport of oil/gas/water-land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Woodward-Clyde Consultants. 1982. Kuparuk Waterflood environmental studies. Draft final report. Prepared for ARCO Alaska, Inc., by Woodward-Clyde Consultants, Anchorage, AK (ADF&G-F, Habitat)

This report of field research conducted during July, August, and September 1982 discusses studies of oceanographic and coastal processes, marine and anadromous fishes, benthic biota, and birds near Oliktok Point, Alaska, that were designed to gather information relating to the potential environmental impacts of construction and operation of a dock and oilfield waterflood intake facility. Species observed included molting and staging black brant, white-fronted geese, and oldsquaw. King eider, glaucous gulls, and loons were also studied. No age or sex information was presented for those birds studied. Habitat in the study area was coastal tundra and lagoon-spit-barrier island complex. The activities of transporting personnel/equipment/material by air and human disturbance produced a documented direct impact of passive harassment. Brant flushed 200-300 m (600-1,000 ft) from a helicopter that approached at an altitude of 30 m (100 ft). When overflown by a helicopter at 60-90 m (200-300 ft) altitude, brant would assume an alert posture but would seldom flush unless repeated overhead passes were made by the helicopter. When approached by a human on foot, brant assumed an alert posture at about 150 m (500 ft) and flew if a closer approach by the human took place. White-fronted geese during the molt would form into a tight group and swim away from shore in an alert posture when overflown by a helicopter at 60-90 m (200-300 ft). During the staging and migration period, white-fronted geese reacted similarly but if circled by a helicopter would flush. During and after the molt, oldsquaws would typically dive under water, usually when the helicopter was directly overhead.

Activity: human disturbance; transport of personnel/equipment/material -air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Zinkl, J.G., J. Rathert and R.R. Hudson. 1978. Diazinon poisoning in wild Canada geese. J. Wildl. Manage. 42(2):406-408. (UAF)

This paper reports the death of 14 Canada geese and the debilitation of one goose due to poisoning by the pesticide diazinon at a golf course in Ladue, Missouri, in November 1975. This study is applicable to Alaska as pesticides are or will undoubtedly be used in some Alaskan farming situations. Chemical application of pesticides was the activity responsible for the documented direct impact of mortality due to ingestion of chemicals and chronic debilitation due to ingestion or contact with chemicals. Laboratory analyses indicated depressed brain enzyme activity when compared with samples from control geese. Diazinon was found in a sample of grass in the mouth of one bird and the depressed levels of enzyme activity indicated poisoning by diazinon. Diazinon had last been applied three months before the die-off, and at the time of application, three or four geese had died on the golf course. Although diazinon is considered to be quite labile in the environment, this incident suggests that so called "short-lived" organic compounds may in fact remain quite toxic to birds months after their last application.

Activity: chemical application.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

18. Seabirds

Table 1. Impacts Associated With Each Activity - Seabirds

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove	?		?				?			?												?								
Aquatic vegetation, destruction or change	?		?	?			?			?					?			?	?	?	?	?			?	?			?	
Attraction to artificial food source	?													?		X						X								
Barriers to movement, physical and behavioral																														
Collision with vehicles or structures								?														X					X		X	
Entanglement in fishing nets, debris																X						X								
Entrapment in impoundments or excavations																														
Harassment, active or passive	?						?	?		?		?		X													X	?	?	
Harvest, change in level																														
Introduced wild/domestic species, competition																														
Morbidity/mortality by ingestion of petroleum				X				?										?	X	X	X				X	X			X	
Parasitism/predation, increased susceptibility													X	X													X	?	?	
Prey base, alteration of			?				?	?		?					?	?		?	?	?	?				?	?			?	
Shock waves (increase in hydrostatic pressure)	X																													
Terrain alteration or destruction	?									?	?	?	X									?								
Veg. composition, change to less preferred				?	?					?			?																	
Veg. damage/destruction due to air pollution				?														?	?	?								?	?	
Veg. damage/destruction due to fire/parasitism		?																												
Veg. damage/destruction due to grazing													X																	
Veg. damage/destruction due to erosion					?						?		?																	
Water level or water quality fluctuations			?				?			?								?			?									

X - Documented impact (see text).
? - Potential impact.

18. SEABIRDS - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on seabirds. Each citation refers to an annotation in the following section, Annotated References to Impacts on Seabirds. Table 1 is a quick index to the impacts and activity for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impacts categories that are not relevant to seabirds are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to seabirds were found for the following activities:

- Burning
- Channelizing waterways
- Clearing and tree harvest
- Draining
- Dredging
- Drilling
- Filling and pile-supported structures (aquatic)
- Grading/plowing
- Log storage/transport
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Transport of personnel/equipment/material - land, ice

Activities definitions and the list of impacts categories are located in appendices C and E, respectively.

1. Blasting:

    a. Shock waves (increase in hydrostatic pressure)

        Cooper 1982

2. Chemical application:

    a. Morbidity/mortality by ingestion of petroleum

Ohlendorf et al. 1978

3. Grazing:

   a. Parasitism/predation, increased susceptibility

      Jones and Byrd 1979

   b. Terrain alteration or destruction

      Jones and Byrd 1979

   c. Veg. damage/destruction due to grazing

      Jones and Byrd 1979

4. Human disturbance:

   a. Harassment, active or passive

      Cooper 1982
      Ellison and Cleary 1978
      Gillett et al. 1975
      Gollop et al. 1974
      Lehnhausen and Quinlan 1981
      Murphy and Hoover 1981
      Robert and Ralph 1975

   b. Parasitism/predation, increased susceptibility

      Ellison and Cleary 1978
      Gillett et al. 1975
      Murphy and Hoover 1981
      Robert and Ralph 1975

5. Netting:

   a. Attraction to artificial food source

      DeGange and Newby 1980

   b. Entanglement in fishing nets, debris

      Ainley et al. 1981
      DeGange and Newby 1980
      King et al. 1979

6. Processing minerals (including gravel):

   a. Morbidity/mortality by ingestion of petroleum

      Ohlendorf et al. 1978

7. Processing oil/gas:

   a. Morbidity/mortality by ingestion of petroleum

      Leighton et al. 1983
      McEwan 1980
      Ohlendorf et al. 1978
      Peakall et al. 1980
      Peakall et al. 1981

8. Sewage disposal:

   a. Morbidity/mortality by ingestion of petroleum

      Ohlendorf et al. 1978

9. Solid waste disposal:

   a. Attraction to artificial food source

      Solman 1978

   b. Collision with vehicles or structures

      Solman 1978

   c. Entanglement in fishing nets, debris

      Paul 1984

10. Transport of oil/gas/water - land:

   a. Morbidity/mortality by ingestion of petroleum

      Leighton et al. 1983
      McEwan 1980
      Peakall et al. 1980
      Peakall et al. 1981

11. Transport of oil/gas/water - water:

    a. Morbidity/mortality by ingestion of petroleum

        Leighton et al. 1983
        Levy 1980
        McEwan 1980
        Ohlendorf et al. 1978
        Peakall et al. 1980
        Peakall et al. 1981

12. Transport of personnel/equipment/material - air:

    a. Collision with vehicles or structures

        Solman 1978

    b. Harassment, active or passive

        Gollop et al. 1974
        Johnson 1984
        Lehnhausen and Quinlan 1981
        Murphy and Hoover 1981

    c. Parasitism/predation, increased susceptibility

        Jones and Byrd 1979

13. Transport of personnel/equipment/material - water:

    a. Collision with vehicles or structures

        Dick and Donaldson 1978

    b. Harassment, active or passive

        Murphy and Hoover 1981

    c. Morbidity/mortality by ingestion of petroleum

        Barrett 1979
        Handel 1979
        McKelvey et al. 1980

    d. Parasitism/predation, increased susceptibility

        Jones and Byrd 1979

B. Organization by Impact Category

Relevant impacts categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to seabirds were found for the following categories:

Aquatic substrate materials, addition or removal
Aquatic vegetation, destruction or change
Barriers to movement
Harvest, change in level
Prey base, alteration of
Vegetation, change to less preferred species
Vegetation damage due to air pollution
Vegetation damage due to fire/parasitism
Vegetation damage due to erosion
Water level or quality fluctuations

Activities definitions and the list of impacts categories are located in appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Netting

      DeGange and Newby 1980

   b. Solid waste disposal

      Solman 1978

2. Collision with vehicles or structures:

   a. Solid waste disposal

      Solman 1978

   b. Transport of personnel/equipment/material - air

      Solman 1978

   c. Transport of personnel/equipment/material - water

      Dick and Donaldson 1978

3. Entanglement in fishing nets, debris:

a. Netting

Ainley et al. 1981
DeGange and Newby 1980
King et al. 1979

b. Solid waste disposal

Paul 1984

4. Harassment, active or passive:

a. Human disturbance

Cooper 1982
Ellison and Cleary 1978
Gillett et al. 1975
Gollop et al. 1974
Lehnhausen and Quinlan 1981
Murphy and Hoover 1981
Robert and Ralph 1975

b. Transport of personnel/equipment/material - air

Gollop et al. 1974
Johnson 1984
Lehnhausen and Quinlan 1981
Murphy and Hoover 1981

c. Transport of personnel/equipment/material - water

Murphy and Hoover 1981

5. Morbidity/mortality by ingestion of petroleum:

a. Chemical application

Ohlendorf et al. 1978

b. Processing minerals (including gravel)

Ohlendorf et al. 1978

c. Processing oil/gas

Leighton et al. 1983
McEwan 1980
Ohlendorf et al. 1978

Peakall et al. 1980
Peakall et al. 1981

d. Sewage disposal

Ohlendorf et al. 1978

e. Transport of oil/gas/water - land, ice

Leighton et al. 1983
McEwan 1980
Peakall et al. 1980
Peakall et al. 1981

f. Transport of oil/gas/water - water

Leighton et al. 1983
Levy 1980
McEwan 1980
Ohlendorf et al. 1978
Peakall et al. 1980
Peakall et al. 1981

g. Transport of personnel/equipment/material - water

Barrett 1979
Handel 1979
McKelvey et al. 1980

6. Parasitism/predation, increased susceptibility:

a. Grazing

Jones and Byrd 1979

b. Human disturbance

Ellison and Cleary 1978
Gillett et al. 1975
Murphy and Hoover 1981
Robert and Ralph 1975

c. Transport of personnel/equipment/material - air

Jones and Byrd 1979

d. Transport of personnel/equipment/material - water

Jones and Byrd 1979

7. Shock waves (increase in hydrostatic pressure):

   a. Blasting

      Cooper 1982

8. Terrain alteration or destruction:

   a. Grazing

      Jones and Byrd 1979

9. Veg. damage/destruction due to grazing:

   a. Grazing

      Jones and Byrd 1979

ANNOTATED REFERENCES TO IMPACTS TO SEABIRDS

The annotated bibliography contains only references that discuss documented impacts to seabirds. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to seabirds are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Ainley, D.G., A.R. DeGange, L.L. Jones, and R.J. Beach. 1981. Mortality of seabirds in high-seas salmon gill nets. Fishery Bull. 79(4):800-806. (UAF)

This field study documents the mortality of 15 species of seabirds caught in Japanese high-seas gill nets in 1978 and 1979 in the North Pacific Ocean and the Bering Sea. The activity of netting produced the documented direct impact of entanglement in fishing nets. Conclusive results indicated that the number of birds caught per unit of net was directly proportional to the density of birds present at the netting locality. Catch rates were particularly high within 90-140 km (50-75 nmi) of the Aleutian Islands, where most of the murres and puffins caught were breeding adults. The authors propose an estimate of 266,500 seabirds killed by the Japanese high-seas mothership fishery for 1978, an increase of 136% over previous estimates for 1978. The authors also suggested that the estimated 4.7 million birds killed by the Japanese North Pacific fishery reported by King et al. (1979) for the years 1952-1974 be at least doubled. Previous studies used statistics averaged over broad areas that did not reflect geographic variations in seabird catch rates and estimates were not adjusted to reflect the higher catch rates associated with commercial net mesh sizes.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Barrett, R.T. 1979. Small oil spill kills 10-20,000 seabirds in north Norway. Mar. Pollut. Bull. 10(9):253-255. (UAF)

This paper reports the death of an estimated 10,000-20,000 seabirds and seaducks from an unknown source of light fuel oil off the coast of north Norway between March 23 and 29, 1979. Approximately 90% of the dead birds were Brunnich's guillemots (Uria lomvia), also known as thick-billed murres. Also killed were an estimated 500-1,000 common, king, and steller's eiders, and oldsquaws. These five species also occur commonly in Alaskan waters. A description of habitat within the affected area was not provided. The activity of transporting personnel/equipment/material by water produced the documented direct impact of mortality due to ingestion of or contact with petroleum products.

Activity: transport of personnel/equipment/material - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Cooper, J. 1982. Methods of reducing mortality of seabirds caused by underwater blasting. Cormorant 10(2):109-114. (ADF&G-F)*

This field study, conducted during the period March through August 1977 in Saldanha Bay, southwestern Cape, South Africa, documented the results of underwater blasting on, and methods to reduce mortality of cape cormorants, kelp gulls, and jackass penguins. Although these species are not found in Alaska, the gull and cormorant are congeneric with Alaskan species and inhabit an area containing cold water currents. Habitat or water depths were not reported. The activities of blasting and human disturbance produced a documented direct impact of active harassment and shock waves. Blasting killed 640 cormorants, 5 gulls, and 454 penguins during the study period. Underwater acoustics (playback of killer whale vocalizations and electronic noises) and gunfire were used as scaring techniques to reduce seabird mortality. Underwater acoustics and gunfire were successfully used to frighten cormorants out of the blast area, although the author believed the reduction in the kill rate may have been as much due to the boat moving in the area as it played the underwater acoustics and to gunfire, as to the acoustics themselves. Underwater acoustics, gunfire, and the reduction of blasting from an early morning-late afternoon schedule to one mid-day blast substantially reduced the kill rate for jackass penguins. Recommendations to minimize the killing of seabirds from blasting included 1) scheduling underwater blasts at a time when few birds are in the vicinity, 2) attempting to undertake only one blast per day or at least avoiding blasts spaced a few hours apart, and 3) prior to a blast, patroling the area by boat and firing guns to scare away birds.

Activity: blasting; human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); shock waves (increase in hydrostatic pressure).

DeGange, A.R., and T.C. Newby. 1980. Mortality of seabirds and fish in a lost salmon drift net. Mar. Pollut. Bull. 11:322-323. (UAF)

This paper reports the discovery of a lost Japanese drift net containing dead seabirds in August 1978 southwest of Attu Island in the North Pacific Ocean. The activity of netting was responsible for the documented direct impacts of entanglement in fishing nets and attraction to an artificial food source. Ninety-nine dead seabirds, primarily shearwaters and tufted puffins, along with 75 dead salmon, were removed from 1,500 m (0.95 mi) of net. During the net salvage, approximately 20 live seabirds were observed at the net, apparently attracted to the net-entangled organisms. It was estimated that the net had been drifting at least 30 days and may have drifted over 100 km (62 mi) in that period.

Activity: netting.

Impact: attraction to artificial food source; entanglement in fishing nets, marine or terrestrial debris, or structures.

Dick, M.H., and W. Donaldson. 1978. Fishing vessel endangered by crested auklet landings. Condor 80(2):235-236. (UAF)

This short paper reports several instances where seabirds collided with and/or landed on fishing and fish-processing vessels during nighttime hours in Kodiak or Aleutian islands waters. Seabirds species that collided with vessels and died were crested and whiskered auklets and, in one instance, king eiders. Strong winds and rough seas during winter months (November-April) were usually associated with the incidents. The activity of transporting personnel/equipment/material by water produced a documented direct impact of collision with vehicles. In one instance, an estimated 6,000 crested auklets landed on an 86-ft-long vessel, apparently attracted to the vessel's running lights. A minimum of 15 dead birds were found on the vessel; the remaining live birds were tossed over the side of the vessel. In another instance, approximately 1,100 dead whiskered auklets were found on a 230-ft fish-processing vessel after a storm. The birds were apparently attracted to the ship's processing lights, which were on continuously during the night. The authors proposed that offshore oil and gas development, with platform lights, flaring gasses, or both, could pose new threats to seabirds that are attracted to lights.

Activity: transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Ellison, L.N., and L. Cleary. 1978. Effects of human disturbance on breeding of double-crested cormorants. Auk 95: 510-517. (UAF)*

This field study was conducted May through August 1975 and 1976 on two islands in the St. Lawrence River estuary, Quebec, Canada, in an attempt to assess the influence of investigators visiting colonies of double-crested cormorants during the breeding season. One island was characterized by rounded spruce- and birch-covered hills bordered in places by 50 m (165 ft) cliffs, and the other was a flat grassy island. Double-crested cormorants are found on the Atlantic and Pacific coasts, including Alaska, and use similar nesting habitat on both coasts. The activity of human disturbance produced documented direct impacts of increased susceptibility to predation and active harassment. Conclusive results showed that frequent visits by investigators caused nest abandonment, increased gull predation, and discouraged late-nesting birds from settling in disturbed experimental colonies. The authors recommended that to prevent nest abandonment, which is most likely to occur early in the nesting season, colonies managed for tourists have restrictions that limit human visitation until late in the nesting cycle, when the young are half grown.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Gillett, W.H., J.L. Hayward, Jr., and J.F. Stout. 1975. Effects of human activity on egg and chick mortality in a glaucous-winged gull colony. Condor 77:492-495. (HD)

This field study was conducted during the summers of 1972 and 1973 on Colville Island, northwest Washington, and examined the effects of human disturbance on the egg and chick mortality of glaucous-winged gulls. Observations and experimenter-induced disturbance (walking through the colony up to several times daily) of gulls were conducted during incubation and chick rearing. Grasses were the dominant vegetation on the 3.8 ha (9.4 acre) island. This island is situated on the southern portion of the breeding range of the glaucous-winged gull, a species which occurs along the coastal reaches of southeast, southcentral, southwest, and western Alaska. The activity of human disturbance produced documented direct impacts of active and passive harassment and increased susceptibility to predation. Conclusive results showed significantly higher chick mortality in experimental plots than in control plots, although patterns of chick mortality between the plots were similar. Egg mortality did not differ between experimental and control plots. The increase in chick mortality was largely due to chicks leaving their home territory as humans approached and venturing into adjacent territories, where they were attacked by neighboring adult gulls. Chicks less than one week old were particularly vulnerable to attack as they have little defense against adult harassment.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Gollop, M.A., J.E. Black, B.E. Felske, and R.A. Davis. 1974. Disturbance studies of breeding black brant, common eiders, glaucous gulls, and arctic terns at Nunaluk Spit and Phillips Bay, Yukon Territory, July, 1972. Pages 153-201 in W.W.H. Gunn and J.A. Livingston, eds. Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rept. Ser., Vol. 14, Chap. 4. (UAF)*

The purpose of this field study, conducted in June and July 1972 at Nunaluk Spit and Phillips Bay, Yukon Territory, Canada, was to determine the effects of helicopters and fixed-wing aircraft and human disturbance on the reproductive success and behavior of breeding black brant, common eiders, glaucous gulls, and arctic terns. The habitat used by breeding and nonbreeding birds was a sparsely vegetated offshore barrier island formation associated with the Firth and Malcolm river deltas, similar to barrier island formations found along coastal Alaska. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment for black brant, glaucous gulls, and arctic terns. The activity of human disturbance produced documented direct impacts of active and passive harassment for all species studies. Conclusive results showed that helicopters produced a greater reaction from incubating birds than did fixed-wing aircraft, except for incubating common eiders, which showed no obvious response to either type of aircraft. Incubating gulls were the most sensitive to human disturbance, with eiders the least sensitive. The responses of arctic terns to human disturbance were not recorded. Nonincubating birds showed greater intolerance to disturbance than did incubating birds. Recommendations included 1) that helicopters stay above 460 m (1,500 ft) when flying over colonies of nesting common eiders, black brant, glaucous gulls, and arctic terns; 2) that fixed-wing aircraft stay above 150 m (500 ft) when flying over such colonies; 3) that flights over colonies at any altitude during the breeding season be kept at an absolute minimum to reduce the possibility of lowering tolerance levels through repeated exposure to passive or active harassment; and 4) that under no circumstances should any person be allowed to visit islands during the period in which they are being used by nesting sea birds.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Handel, C.M. 1979. Preliminary assessment of impacts to bird resources from the grounding of the F/V Ryuyo Maru No. 2 on St. Paul Island, Alaska. Unpubl. manuscript. USFWS, Anchorage, AK. 17 pp. (ADF&G-F, Habitat)

This report summarizes the results of a field reconnaissance conducted from 14-16 November 1979 to assess the immediate and predicted impacts to birds from the 8 November 1979 grounding of the 300 ft Japanese fishing vessel Ryuyo Maru No. 2 on St. Paul Island, Alaska. The activity of transporting personnel/equipment/material by water produced a documented direct impact of morbidity and mortality due to ingestion of or contact with petroleum. Eight days after the grounding, an estimated 100,000 gallons of diesel oil had leaked from the vessel, polluting nearshore waters immediately adjacent to seabird nesting cliffs and the only saltwater lagoon on the island. Dead birds found oiled on St. Paul Island included 33 glaucous-winged gulls, 11 harlequin ducks, 3 thick-billed murres, 1 common murre, and one crested auklet. Large numbers of glaucous-winged gulls and harlequin ducks were observed bathing and preening in the contaminated waters of the saltwater lagoon. Several potential impacts to birds were described, and included 1) attraction of birds to fish contained in the ships hold that could be released to polluted waters, 2) contamination of breeding areas and subsequently of breeding least auklets and their eggs the following spring, 3) the potential release to the sea of unsecured gillnets aboard the vessel and the subsequent danger of entanglement of seabirds and fur seals, and 4) decreased use of nesting cliffs immediately above the grounded ship by thick-billed and common murres and least auklets.

Activity: transport of personnel/equipment/material - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Johnson, S.R. 1984. Habitat use and behavior of nesting common eiders and molting oldsquaws at Thetis Island, Alaska, during a period of industrial activity. LGL Alaska Research Associates, Inc. for Sohio Alaska Petroleum Company. (ADF&G-F, Habitat)

This field study was conducted from May through August 1983 on Thetis and Spy Islands, two sand-and-gravel-covered barrier islands in the central portion of the Alaskan Beaufort Sea coast near the mouth of the Colville River delta and Oliktok Point, respectively. Objectives of the study were to 1) determine the number, distribution, and breeding success of common eiders on Thetis Island, 2) enhance common eider nesting habitat on Spy Island, and 3) determine the number and distribution of molting oldsquaws near Thetis Island during the mid-summer molt period. These objectives were chosen in an attempt to determine if gravel stockpiling on Thetis Island during winter, gravel movement from Thetis Island by barge to an artificial island site during summer, and associated construction activity would disturb local populations of nesting eiders and molting oldsquaws. Habitat on Thetis and Spy islands consisted of sand and gravel with varying densities of driftwood (high-density driftwood areas were preferred common eider nesting habitat). The activities of human disturbance and transporting personnel/equipment/material by air produced a documented direct impact of harassment. A low-level flight (altitude not reported) over Thetis Island by a helicopter caused a pair of glaucous gulls to flush from their nest area and a pair of common eiders and an oldsquaw to flush from a meltwater area on the island. Several nests of common eiders were abandoned during egg-laying, the result of humans walking near the nest sites. Eggs in these abandoned clutches were apparently eaten by glaucous gulls. Additional visits by humans to the island during later stages of incubation also led to abandonment of one nest and caused disruption of incubation of eggs and rearing of hatchlings. The limited disturbance to nesting waterfowl on the islands during this study was attributed by the author in large part to the establishment of an aircraft flight corridor and buffer zone that for the most part kept helicopters and fixed-wing aircraft at least 1.8 km (1 mi) from either Thetis or Spy island.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Jones, R.D., and G.V. Byrd. 1979. Interrelations between seabirds and introduced animals. Pages 221-226 in J.C. Bartonek and D.N. Nettleship, eds. Conservation of marine birds of northern North America. USFWS Wildl. Res. Rept. 11. (UAF)

The purpose of this review paper was to discuss the effects of introduced animals on seabirds and their nesting habitat on islands, with emphasis on islands off the coasts of Washington, British Columbia, and Alaska. References discussed included papers dating to 1831, although quantitative data were confined to the 1970's. Seabirds, when specific species were mentioned, included shearwaters, puffins, auklets, petrels, and murrelets. The effects of introduced species on the Aleutian Canada goose were also discussed. The activities of grazing (furfarming) and transporting personnel/equipment/material by air and water produced a documented direct impact of increased susceptibility to predation. Documented indirect impacts associated with the above activities were vegetation damage/destruction due to grazing by introduced domestic animals and terrain destruction and alteration. A potential impact discussed was the increased susceptibility of seabirds and geese in the Aleutian Islands to parasitism by a blood parasite carried by introduced black flies. Conclusive results were that foxes introduced to the Aleutian Islands eliminated the Aleutian Canada goose from all but one of its nesting islands. Introduced rats were found to prey on young seabirds on some New Zealand islands. Introduced rats are also present on some islands in the Aleutian chain, but the effects of these introductions have not been documented. Introduced sheep on an island in Washington were reported to have grazed and trampled nesting areas of burrowing seabirds. Landslides initiated by these activities buried burrows and rendered the slopes unusable by burrowing seabirds.

Activity: grazing; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: parasitism and predation, increased susceptibility to; terrain alteration or destruction (e.g., raptor cliffs); vegetation damage/destruction due to grazing by domestic or introduced animals.

King, W.B., R.G.B. Brown, and G.A. Sanger. 1979. Mortality to marine birds through commercial fishing. Pages 195-199 in J.C. Bartonek and D.N. Nettleship, eds. Conservation of marine birds of northern North America. USFWS. Wildl. Res. Rept. 11. (UAF)

This review paper discusses the mortality of adult seabirds associated with inshore and offshore commercial fisheries in the North Atlantic and North Pacific oceans. Data from the 1950's through the 1970's are presented, documenting the mortality of primarily alcids, although albatrosses, shearwaters, and petrels are also discussed. The activity of netting produced the documented direct impact of entanglement in fishing nets. Quantitative mortality data for inshore Alaska salmon fisheries are not presented, although mortality of seabirds in Cook Inlet is said to occur from beach set nets and drift nets near seabird rookeries. Estimates of seabird mortality by the Japanese offshore North Pacific salmon gill net fishery for 1974 ranged between 214,000 and 715,000 birds. As many as 4.7 million birds are estimated to have been killed by the Japanese salmon gill net fishery during the period 1952 through 1974. Prior to its termination in 1975, the offshore North Atlantic salmon gill net fishery annually killed an estimated 250,000 to 750,000 murres, based on research conducted in 1969 and 1970.

Activity: netting.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Lehnhausen, W.A., and S.E. Quinlan. 1981. Bird migration and habitat use at Icy Cape, Alaska. Unpubl. manuscript. USFWS, Anchorage, AK. 298 pp. (ADF&G-F, Habitat)*

This reference reports the results of field studies conducted May through September 1980 on the use of the Icy Cape area of northwestern Alaska by wildlife. A major component of the studies involved quantifying bird migration past Icy Cape and local use of the area by birds. The Icy Cape area is part of an extensive barrier island/lagoon system (Kasegaluk Lagoon). Habitat within the area includes sparsely vegetated barrier islands, a shallow lagoon, salt marsh, tundra, and freshwater wetlands. The activities of transporting personnel/equipment/material by air and human disturbance produced a documented direct impact of harassment. Aircraft flying at altitudes of 15-60 m (50-200 ft) over the barrier islands and the lagoon disturbed nesting, feeding, and resting birds. Common eiders flushed off their nests in mass panic flights when overflown by aircraft at low altitudes. Molting oldsquaws frequently moved from shore or dove as aircraft passed overhead. Glaucous gulls, arctic terns, and black brant flushed from the lagoon or from the barrier islands when overflown by aircraft at low altitudes. During fall migration, flocks of 100-500 black brant on salt marsh areas flushed when humans on the ground were 3-4 km (1.9-2.5 mi) away. Researchers conducting bird surveys also caused nesting birds to flush from their nests. The authors recommended that human activity on the barrier islands be restricted between 15 June and 15 September to protect nesting and molting birds. Several recommendations regarding the prohibition or restriction of development activities (e.g., oil and gas exploration and development, gravel sources, staging areas) were proposed for the barrier island/lagoon systems/nearshore waters. These recommendations were based on perceived potential impacts to the birds of the area and their habitat.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Leighton, F.A., D.B. Peakall, and R.G. Butler. 1983. Heinz body hemolytic anemia from the ingestion of crude oil: a primary toxic effect in marine birds. Science 220(4599):871-873. (ARL)#

Haemolytic anemia developed in young herring gulls and Atlantic puffins given daily oral doses of a Prudhoe Bay crude oil. Anemia developed four to five days after the initiation of oil ingestion and was accompanied by Heinz body formation and a strong regenerative response. The findings show a toxic effect on circulating red blood cells involving an oxidative biochemical mechanism and the first clear evidence of a primary mechanism of toxicity from the ingestion of crude oil by birds.

Activity: processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Levy, E.M. 1980. Oil pollution and seabirds: Atlantic Canada 1976-77 and some implications for northern environments. Mar. Pollut. Bull. 11:51-56. (HD)#

Chemical analyses of the oils on dead or moribund seabirds from Atlantic Canada during the winter of 1976-1977 indicated that some of the birds were contaminated with oil spilled by the Argo Merchant grounding, some by oil probably from the Grand Zenith sinking, and still others by oil from various small local spills of unknown origin. These victims demonstrated that an extremely minute oiling may lead to the death of a seabird when the effects of the oil are synergistically combined with the stresses imposed by severe environmental conditions. This may intensify the impact of oil in the arctic and thereby have a profound effect on seabird populations.

Activity: transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

McEwan, E.H. 1980. Uptake and clearance of petroleum hydrocarbons by the glaucous-winged gull and mallard duck. Can. J. Zool. 58(5):723-726. (USFWS)#

Glaucous-winged gulls and mallard ducks fed tritiated crude oils showed a rapid uptake of labelled hydrocarbons into tissues and plasma. About 45% of the ingested oil was excreted. After 24 hours, tritiated hydrocarbon concentrations in the plasma and tissues declined to background level except for bunker-C-fed birds and stressed, oil-fed gulls.

Activity: processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

McKelvey, R.W., I. Robertson, and P.E. Whitehead. 1980. Effect of non-petroleum oil spills on wintering birds near Vancouver. Mar. Pollut. Bull. 11:169-171. (HD)#

The danger of oil pollution to aquatic birds is widely acknowledged; petroleum oils are well known for their ability to reduce or eliminate feather water-proofing, resulting in exposure and ultimately death. However, petroleum products are not the only potential source of oil pollution to aquatic birds. Recently, spills of vegetable oils at Vancouver harbor have caused greater losses of birds than spills of petroleum oils. Vegetable oils affect birds by feather-wetting but do not exhibit the odor and slick characteristics of petroleum oils. Because most vegetable oils are edible, their potential danger to aquatic birds may go unnoticed; sites of storage and shipment of vegetable oils may be overlooked for their potential hazard.

Activity: transport of personnel/equipment/material - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Murphy, E.C. and A.A. Hoover. 1981. Research study of the reactions of wildlife to boating activity along Kenai Fjords coastline. Final rept. to Nat. Park Serv., USDI, by AK Coop. Park Stud. Unit, Univ. Alaska, Fairbanks. x + 125 pp. (UAF)*

This report presents results of field studies conducted between May and August of 1979 and 1980 on harbor seals (Phoca vitulina) and glaucous-winged gulls (Larus glaucescens) primarily in Aialik Bay on the Kenai Peninsula. Distribution, abundance, habitat utilization, and responses to human activity (aircraft and boating) were studied.

Harbor seals. The predominant feature of Aialik Bay harbor seal habitat utilization is that large (1-7 m [3.3-23.0 ft] diameter) icebergs from the Aialik Glacier are the preferred haulout habitat, especially where a large number of these bergs are rafted together. Bergs are especially used during pupping and molting, although during molting (July-August) the area is used mostly by juveniles. Because the mother/pup bond is relatively weak shortly after pupping and because harbor seals pup on the drifting bergs, disturbance during this period can be especially harmful. Two incidents of probable abandonment were observed. In addition, higher pup mortality was noted in 1979 when an unusual period of northeasterly wind blew the ice out of the bay, and many pups were unable to haul out onto the rocks. Increased distress vocalization by pups less than a week old was noted by the observers, which likely corresponded to increased abandonment. These incidents reinforce the importance of minimizing disturbance during pupping.

The authors noted responses of seals to three sources of disturbance - boats less than 6 m (20 ft) in length, boats greater than 6 m (20 ft) in length, and aircraft. In general, females with young pups were more reluctant to leave the bergs [Rev. note: although the authors attribute this to decreased "wariness," it was more likely due to a reluctance of the female to leave the pup on the berg] than juveniles and adults without pups. Only a small proportion (less than 2%) of the reactions were "panic" responses.

Factors that affected responsiveness to disturbance included the density of the group, ice conditions, and factors associated with the disturbance source (e.g., motor size, speed of approach). "Low" [Rev. note: "low" and "high" density were not defined] density groups were more reactive - i.e., seals left the berg when the boat was farther away - than "high" density groups. During poor ice conditions - i.e., lower number of optimally sized bergs available - females with pups were less likely to leave the bergs than during good ice conditions. The noise levels associated with larger motors, higher speed of approach, and amount of human movement in the vessel were directly related to the amount of disturbance. Aircraft altitude was inversely correlated with disturbance - flights at less than 30 m (100 ft) elevation caused approximately 2/3 of the hauled out seals to abandon bergs. Overflights at elevations higher than 75 m (250 ft) usually evoked mild or no response.

The authors suggested guidelines, including the following:

- During pupping, boats should remain 100 m (328 ft) from parturient seals; at all other times, they should remain at least 60 m (200 ft) from hauled-out seals.

- Boats should approach hauled-out seals slowly and with a minimum of on-board human movement.

- Aircraft should avoid flying over hauled-out seals, especially during pupping.

- If aircraft cannot avoid flying over hauled-out seals, the aircraft should maintain an elevation of at least 75 m (250 ft) and a constant airspeed and direction.

Glaucous-winged gulls. Responses of mew gulls and arctic terns to human activity were also noted. Observations of glaucous-winged gulls within Aialik Bay were conducted on Squab Island, a small island with a maximum elevation of 40 m (130 ft), vegetated primarily with grasses and umbeliferous plants. The activities of human disturbance and transporting personnel/equipment/material by water and air produced documented direct impacts of active and passive harassment and increased susceptibility to predation. Glaucous-winged gulls, when approached by humans, flew off their nests and remained airborne until humans left the vicinity of the nests (4-10 m [12-32 ft]). Eggs at unattended nests were eaten by other gulls when the breeding birds took flight in response to human disturbance. Glaucous-winged gulls did not respond to the approach of the researcher's Zodiac boat for the initial two weeks of the 1979 study segment; after two weeks, the gulls took flight upon approach within 50 to 75 m (164-236 ft). This behavior was selective to the Zodiac boat; larger vessels passing within 60 m (200 ft) of the island did not elicit a flight response. When approached by boat, feeding flocks parted to allow the boat to pass, then reformed and resumed feeding. Gulls did not respond to aircraft flying at elevations of 60 to 140 m (200-460 ft) over the island. When aircraft approached within several meters, all gulls took flight. Mew gulls flushed from their nest when humans approached to within 10-100 m (33-330 ft). Adult mew gulls were most sensitive to disturbance during the egg-hatching period. Arctic terns responded similarly to mew gulls.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Ohlendorf, H.M., R.W. Risebrough, and K. Vermeer. 1978. Exposure of marine birds to environmental pollutants. USFWS, Wildl. Res. Rept. 9. 40 pp. (UAF)

This review paper discusses the effects of hydrocarbons, organochlorides, heavy metals, and plastics on marine birds. The scope of this paper is worldwide, although most references pertain to studies from coldwater regions. Several studies were conducted in Alaskan waters. The majority of the papers reviewed were published in the 1960's and 1970's. Numerous seabirds were studied, including puffins, gulls, kittiwakes, terns, cormorants, murres, auklets, guillemots, petrels, fulmars, terns, and sea ducks. Hydrocarbon- associated activities that affected marine birds were transport of oil/gas by water, processing of oil/gas and sewage disposal. A documented direct conclusive impact was morbidity or mortality due to ingestion of or contact with petroleum or petroleum products (e.g., oiling of feathers, death). Organochloride-associated activities that affected marine birds were processing of oil/gas, processing of minerals, chemical application, and sewage disposal. Documented indirect conclusive impacts were morbidity or mortality due to ingestion or contact with chemicals (e.g., eggshell thinning, pesticide residues in tissues). Activities associated with heavy metals were processing of minerals, processing of oil/gas, and sewage disposal. The conclusive documented direct impact associated with heavy metals was morbidity or mortality due to ingestion of chemicals (e.g., mercury compounds in tissues and eggs). Plastics, manufactured by processing of oil/gas, are discussed as potentially impacting seabirds by way of chronic debilitation due to ingestion of petroleum products.

Activity: chemical application; processing minerals (including gravel); processing oil/gas; sewage disposal; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Paul, T. 1984. A plague of plastics. Alaska Fish and Game 16(3):2-5. (ADF&G-F)

This popular article examines the problem of discarded or lost plastic items polluting Alaska's marine shoreline and harming wildlife. The article presents brief descriptions of studies conducted in Alaska documenting some impacts of plastics on wildlife (gulls, brown bear, furseals and other marine mammals) and also presents some original observations and photographs. The studies briefly described were conducted in the 1970's. The activities of processing oil/gas (plastic manufacturing), netting, and solid waste disposal produced documented direct impacts of entanglement in fishing nets and marine debris and morbidity due to ingestion of or contact with petroleum products (plastic). One photograph showed a gull, which later died, with its bill entangled in a plastic beverage carrier. Brown bears, dolphins, and whales have been found with plastic items within their digestive systems.

Activity: solid waste disposal.

Impact: entanglement in fishing nets, marine or terrestrial debris, or structures.

Peakall, D.B., D. Hallett, D.S. Miller, R.G. Butler, and W.B. Kinter. 1980. Effects of ingested crude oil on black guillemots: a combined field and laboratory study. Ambio. 9(1):28-30. (UAA)#

A single oral dose (0.1 ml, 0.2 ml, or 0.5 ml) of weathered crude oil reduced weight gain, increased plasma Na^+ level, and markedly increased adrenal gland weight in black guillemots.

Activity: processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Peakall, D.B., J. Tremblay, W.B. Kinter, and D.S. Miller. 1981. Endocrine dysfunction in seabirds caused by ingestion of oil. Environ. Res. 24(1):6-14. (UAF)#

A single oral dose (0.1-1.0 ml) of certain crude oils or aromatic fractions of them caused elevated plasma corticosterone and thyroxine levels in nesting herring gulls and black guillemots. In gulls, plasma corticosterone increased within one day after dosing, the maximum effect being observed after four days (about 50% higher than control levels); levels returned to normal after two weeks. Thyroxine levels did not increase until six days after dosing, and they remained high after two weeks. Since only those oils that reduced seabird growth rates affected hormone levels, endocrine disorders may cause depressed growth.

Activity: processing oil/gas; transport of oil/gas/water - land; transport of oil/gas/water - water.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Robert, H.C., and C.J. Ralph. 1975. Effects of human disturbance on the breeding success of gulls. Condor 77:495-499. (HD)

This field study, conducted during April-July 1968, examined the effects of human disturbance on the breeding success of a colony of western gulls on Southeast Farallon Island, California. Although not present in Alaska, this species is congeneric with and exhibits behavioral traits common to coastal colony nesting gull species found in Alaska. A description of habitat in and around the nesting colony was not provided. The activity of human disturbance produced documented direct impacts of active harassment and increased susceptibility to predation. One person walked slowly through the study plots for 30 minutes up to three times each day as the source of human disturbance during incubation and during chick rearing. Conclusive results showed that during the incubation phase, the daily loss of eggs or very small immobile young was directly proportional to the degree of disturbance. The principal cause of egg loss was destruction by another gull after the incubating bird had been flushed from the nest by the researcher. Mortality of young during the chick-rearing phase was inversely proportional to the amount of disturbance. Occasionally, disturbed chicks reacted strongly to the researcher's presence by running into other territories and being attacked by adults, whereas frequently disturbed chicks were less frightened, less likely to move into other gull territories, and less likely to be attacked by adult gulls.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Solman, V.E.F. 1978. Gulls and aircraft. Environ. Conserv. 5(4):277-280. (UAF)

This review paper examines the problem of collisions between birds, primarily gulls, and aircraft. Gull aircraft incidents discussed occurred worldwide, although the major emphasis was on incidents that occurred in Canada. Information concerning specific species of gulls or ages and sexes of gulls involved in collisions was not presented. Although no gull-aircraft incidents within Alaska were discussed, situations giving rise to bird-aircraft collisions either can or do occur in Alaska and are therefore considered here. The activities of solid waste disposal and transporting personnel/equipment/material by air produced a direct impact of attraction to an artificial food source and a direct and indirect impact of collision with vehicles. As many as 315 gull carcasses were found after a collision with a small business-type jet aircraft. Gulls were attracted to improperly stored or handled garbage at airports. Gulls were also attracted to shopping centers, recreation areas, or garbage dumps that were often several miles from the airport. These gulls routinely flew over the airports or through the approach and departure routes of aircraft as the gulls travelled between resting areas and the dumps, shopping centers, or other man-made foraging areas. Gulls were also attracted to grass-mowing machinery at airports and would feed on rodents that were easily visible in the freshly mowed grass. Airports in coastal areas were particularly likely to have bird-aircraft collision incidents.

Activity: solid waste disposal; transport of personnel/equipment/ material - air.

Impact: attraction to artificial food source; collision with vehicles or structures, or electrocution by powerlines.

19. Trumpeter Swan

Table 1. Impacts Associated With Each Activity - Trumpeter swan

Impacts \ Activity	Blasting	Burning	Channelizing waterways	Chemical application	Clearing and tree harvest	Draining	Dredging	Drilling	Fencing	Filling and pile-supported structures (aquatic)	Filling (terrestrial)	Grading/plowing	Grazing	Human disturbance	Log storage/transport	Netting	Processing geothermal energy	Processing lumber/kraft/pulp	Processing minerals (including gravel)	Processing oil/gas	Sewage disposal	Solid waste disposal	Stream crossing - fords	Stream crossing - structures	Transport of oil/gas/water - land,ice	Transport of oil/gas/water - water	Transport of personnel/equipment/material - air	Transport of personnel/equipment/material - land,ice	Transport of personnel/equipment/material - water	Water regulation/withdrawal/irrigation
Aquatic substrate materials, add or remove	?		?			?	?			?									?				?							
Aquatic vegetation, destruction or change	?		?	?		?	?			?		?	?		?			?	?	?	?	?	?		?	?				?
Attraction to artificial food source												?	X									?								
Barriers to movement, physical and behavioral												?																?		
Collision with vehicles or structures									X																		X	X	?	
Entanglement in fishing nets, debris																														
Entrapment in impoundments or excavations																			?	?										
Harassment, active or passive	?							X				X		X											X		X	X	X	
Harvest, change in level																														
Introduced wild/domestic species, competition														?								?								
Morbidity/mortality by ingestion of petroleum				?										?				?	X	?		X			?	?				
Parasitism/predation, increased susceptibility						?				?		?	?	X													?	X	X	?
Prey base, alteration of																														
Shock waves (increase in hydrostatic pressure)																														
Terrain alteration or destruction			?		?	?	?			?		?										?								?
Veg. composition, change to less preferred			?	?	?	?	?			?		?																		?
Veg. damage/destruction due to air pollution				?														?	?	?	?							?	?	
Veg. damage/destruction due to fire/parasitism		?																												
Veg. damage/destruction due to grazing													?																	
Veg. damage/destruction due to erosion					?					?		?										?								
Water level or water quality fluctuations			?			?	?			?		?									?									?

X - Documented impact (see text).
? - Potential impact.

19. TRUMPETER SWAN - IMPACTS CITATIONS

This section consists of lists of citations to annotated references about documented impacts of human land uses and development types on trumpeter swan. Each citation refers to an annotation in the following section, Annotated References to Impacts on Trumpeter Swan. Table 1 is a quick index to the impacts and activities for which documentation has been located. The organization of this section is by activity in subsection A and by impact category in subsection B. Activities and impact categories which are not relevant to trumpeter swan are not included in this section.

A. Organization by Activity

Relevant activities for which no documented impacts have been found are listed below; however, this should not imply that such activities would necessarily result in no impact.

No documented impacts to trumpeter swan were found for the following activities:

- Blasting
- Burning
- Channelizing waterways
- Chemical application
- Clearing and tree harvest
- Draining
- Dredging
- Filling and pile-supported structures (aquatic)
- Filling (terrestrial)
- Log storage/transport
- Netting
- Processing geothermal energy
- Processing lumber/kraft/pulp
- Processing oil/gas
- Sewage disposal
- Stream crossing - fords
- Stream crossing - structures
- Transport of oil/gas/water - water
- Water regulation/withdrawal/irrigation

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Drilling:

    a. Harassment, active or passive

Barry and Spencer 1976
Sopuck et al. 1979

2. Fencing:

   a. Collision with vehicles or structures

      Banko 1960

3. Grading/plowing:

   a. Harassment, active or passive

      Richey 1981

4. Grazing:

   a. Attraction to artificial food source

      McKelvey 1979

5. Human disturbance:

   a. Harassment, active or passive

      Bangs et al. 1982
      Hansen et al. 1971
      McKelvey et al. 1983
      Richey 1981
      Shepherd 1962
      Timm 1981

   b. Parasitism/predation, increased susceptibility

      Hansen et al. 1971
      McKelvey et al. 1983

6. Processing minerals (including gravel):

   a. Morbidity/mortality by ingestion of petroleum

      Chupp and Dalke 1964

7. Solid waste disposal:

a. Morbidity/mortality by ingestion of petroleum

Chupp and Dalke 1964

8. Transport of oil/gas/water - land, ice:

a. Harassment, active or passive

Wiseley 1974

9. Transport of personnel/equipment/material - air:

a. Collision with vehicles or structures

Hansen et al. 1971

b. Harassment, active or passive

Barry and Spencer 1976
Hansen et al. 1971
Renken et al. 1983
Richey 1981
Shepherd 1962
Slaney and Co. 1973
Sopuck et al. 1979
Timm 1981

10. Transport of personnel/equipment/material - land, ice:

a. Collision with vehicles or structures

Banko 1960
Sopuck et al. 1979

b. Harassment, active or passive

Hansen et al. 1971
Richey 1981
Slaney and Co. 1973
Timm 1981

c. Parasitism/predation, increased susceptibility

Hansen et al. 1971

11. Transport of personnel/equipment/material - water:

a. Harassment, active or passive

Barry and Spencer 1976
Hansen et al. 1971
Richey 1981

b. Parasitism/predation, increased susceptibility

Hansen et al. 1971

B. Organization by Impact

Relevant impact categories for which no documented impacts have been found are listed below; however, this should not imply that such impacts would not occur.

No documented impacts to trumpeter swan were found for the following categories:

Aquatic substrate materials
Aquatic vegetation, destruction or change
Barriers to movement, physical and behavioral
Entanglement in fishing nets, debris
Entrapment in impoundments or excavations
Harvest, change in level
Introduced wild/domestic species, competition
Prey base, alteration of
Shock waves (increase in hydrostatic pressure)
Terrain alteration or destruction
Veg. composition, change to less preferred
Veg. damage/destruction due to air pollution
Veg. damage/destruction due to fire/parasitism
Veg. damage/destruction due to grazing
Veg. damage/destruction due to erosion
Water level or water quality fluctuations

Activities definitions and the list of impacts categories are located in Appendices C and E, respectively.

1. Attraction to artificial food source:

   a. Grazing

      McKelvey 1979
      Banko 1960

   b. Transport of personnel/equipment/material - air

      Hansen et al. 1971

   c. Transport of personnel/equipment/material - land, ice

      Banko 1960
      Sopuck et al. 1979

2. Collision with vehicles or structures:

   a. Fencing

3. Harassment, active or passive:

   a. Drilling

      Barry and Spencer 1976
      Sopuck et al. 1979

   b. Grading/plowing

      Richey 1981

   c. Human disturbance

      Bangs et al. 1982
      Hansen et al. 1971
      McKelvey et al. 1983
      Richey 1981
      Shepherd 1962
      Timm 1981

   d. Transport of oil/gas/water - land, ice

      Wiseley 1974

   e. Transport of personnel/equipment/material - air

      Barry and Spencer 1976
      Hansen et al. 1971
      Renken et al. 1983
      Richey 1981
      Shepherd 1962
      Slaney and Co. 1973
      Sopuck et al. 1979
      Timm 1981

   f. Transport of personnel/equipment/material - land, ice

      Hansen et al. 1971
      Richey 1981
      Slaney and Co. 1973
      Timm 1981

   g. Transport of personnel/equipment/material - water

      Barry and Spencer 1976
      Hansen et al. 1971
      Richey 1981

4. Morbidity/mortality by ingestion of petroleum:

a. Processing minerals (including gravel)

Chupp and Dalke 1964

b. Solid waste disposal

Chupp and Dalke 1964

5. Parasitism/predation, increased susceptibility:

a. Human disturbance

Hansen et al. 1971
McKelvey et al. 1983

b. Transport of personnel/equipment/material - land, ice

Hansen et al. 1971

c. Transport of personnel/equipment/material - water

Hansen et al. 1971

ANNOTATED REFERENCES TO IMPACTS TO TRUMPETER SWANS

The annotated bibliography contains only references that discuss documented impacts to trumpeter swans. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertained to trumpeter swans are listed below each annotation. Annotations that contain an asterisk after the library identifier within the citation (e.g., [UAF]*) will be used to develop the habitat management guidelines to be found in the guidelines volume. The abbreviations in parentheses (e.g., [UAF]) refer to the physical location of the reference. Abbreviations are explained in appendix G. Annotations that contain the symbol (#) after the library identifier within the citation were originally produced for the Alaska Habitat Management Guide-Southwest Region under slightly different criteria than are currently being used. These annotations were deemed applicable and met the inclusion criteria for the current product. The format of this section displays one annotation per page in order to make it easy to update this volume with additional annotations.

Bangs, E.E., T.H. Spraker, T.N. Bailey, and V.D. Berns. 1982. Effects of increased human populations on wildlife resources of the Kenai Peninsula, Alaska. Trans. N. Am. Wildl. Nat. Resour. Conf. 47:605-616. (UAF)

This paper reviews the historical impacts, management techniques and potential human impacts on trumpeter swans, Bald Eagles, salmon, wolves, caribou, and moose on the Kenai Peninsula, Alaska. The information reviewed dates to the early 1900's, although the majority of the impact-related information is from the 1960's and 1970's. Habitat types in the area range from coastal forest to alpine tundra.

Trumpeter swans. The activity of human disturbance produced the direct documented and potential impacts of active and passive harassment. Human disturbance associated with residential and industrial development was suspected to have caused abandonment of a spring staging area and several nest sites. Continued disturbance was expected to occur with further human development within the area.

Bald Eagle. The activities of human disturbance and transporting personnel/equipment/material by water produced documented direct impacts of active and passive harassment. Eaglet production was substantially less in areas subjected to human disturbance than in areas subjected to little disturbance. Potential impacts that may be associated with roads and transmission lines from the Bradley Lake power project include electrocution from contact with powerlines and passive harassment.

Moose. The activities of human disturbance and transporting personnel/equip- ment/material by land resulted in direct, documented impacts of moose colliding with vehicles and increased susceptibility to predation. Conclusive results show that between 1970 and 1980 an average of 150 moose were killed annually by colliding with vehicles, and that an undetermined number of calves were killed by domestic dogs.

Wolves. The activities of human disturbance and processing minerals resulted in direct, documented impacts of disease transmission from domesticated animals, passive harassment, and drastically increased harvest. By 1915, widespread use of poison and unregulated hunting and trapping had extirpated wolves from the Kenai Peninsula. After recolonization, it is believed that at least one wolf pack has been reduced by contracting distemper from domestic dogs. Intensively developed lands, which wolves avoid, have reduced wolf habitat on the Kenai Peninsula.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Banko, W.E. 1960. The trumpeter swan: its history, habits, and population in the United States. USFWS, N. Am. Fauna No. 63. 214 pp. (UAF)

This major review/research paper discusses the distribution, habitat use, breeding biology, and population dynamics of trumpeter swans. Much of this paper deals with swans found in the Red Rocks Lake area of Montana. Additional information, although often limited in extent, is presented for swans found in Idaho, Washington, Wyoming, and Alaska. References reviewed date to 1784, but the majority were from 1900 to 1957. The bulk of the actual data presented was from the 1930's through 1957. The activities of fencing and transporting personnel/equipment/material by land produced a documented direct impact of collision with structures. At least four swans were killed after colliding with fences, telephone lines, or power lines. The remainder of the limited impact-related information in this paper dealt with hunting and lead poisoning of swans.

Activity: fencing; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines.

Barry, T.W., and R. Spencer. 1976. Wildlife response to oil well drilling. Can. Wildl. Serv. Prog. Notes No. 67. Canadian Wildlife Service, Edmonton, Alberta. 15 pp. (HD)*

A field study of the effects of oil-well drilling on wildlife in the vicinity of the Taglu G-33 site in the MacKenzie River delta, Northwest Territories, Canada, was conducted during June, July, and August 1971. Species studied included nesting and molting Canada, white-fronted, and snow geese, whistling (tundra) swans, and dabbling and diving ducks. Habitat within the area is coastal tundra. The activity of drilling produced a documented direct impact of passive harassment. Whistling swans, white-fronted geese, Canada geese, pintails, green-winged teal, and scaup were less abundant in plots within 2.5 km (1.5 mi) of the drill rig than in control plots 8 km (5 mi) distant. Molting flocks or family groups of whistling swans, white-fronted geese, Canada geese, and snow geese moved or stayed more than 2.5 km (1.5 mi) from the drill rig. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment and increased susceptibility to predation. Swans and geese flushed, swam, or ran from a helicopter at distances ranging from 10 m to 2.4 km (30 ft to 1.5 mi), depending on species and their stage of incubation or molt. Snow geese would flush from their nests from 0.8 to 2.4 km (0.5 to 1.5 mi) ahead of the helicopter and would begin to return to the nest site when the helicopter was 0.8 km (0.5 mi) past the nest site. Resettling on the nests took up to 45 min after passage of the helicopter, because fights occurred as the disturbed birds crossed the territories of others to regain their own nests. Gulls and jaegers preyed on goose eggs more heavily than usual when the disturbed geese were off their nests. The activity of transporting personnel/equipment/material by water produced a documented direct impact of passive harassment. Ducks and swans either flushed or swam as a supply tug and barge approached.

Activity: drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Chupp, N.R., and P.D. Dalke. 1964. Waterfowl mortality in the Coeur d'Alene River valley, Idaho. J. Wildl. Manage. 28(4):692-702. (UAF)

This field study/historical review examined the causes of outbreaks of waterfowl mortality from the early 1900's to the early 1960's in northern Idaho's Coeur d'Alene River valley. Losses of whistling (tundra) swans were the primary focus of this study, although information for other waterfowl is also presented. Whistling swans are spring migrants in the Coeur d'Alene River area. The study area contains lakes and marshes, some of which remain ice free in late winter-early spring and are used by wintering and migrating waterfowl. Limited information on trumpeter swans requires that information on the closely related whistling swan be considered. The activities of processing minerals and solid waste disposal were responsible for the documented direct impact of morbidity and mortality due to ingestion of heavy metals. From 1924 to 1955, several hundred swans died during spring migration. Postmortem examination of several swans collected during this period indicated metallic poisoning as the cause of death. Lead, zinc, and copper were found in high concentrations in samples of internal organs of the examined swans. Abnormally high concentrations of lead, zinc, and copper were in numerous plant and soil samples. It was suspected that the swans ingested the heavy metals while feeding on contaminated vegetation growing on contaminated substrate. Contamination of the Coeur d'Alene River valley by waste products from mines and smelters since the turn of the century was considered the prime cause of the long history of waterfowl losses in the valley.

Activity: processing minerals (including gravel); solid waste disposal.

Impact: morbidity or mortality due to ingestion of or contact with petroleum.

Hansen, H.A., P.E.K. Shepherd, J.G. King, and W.A. Troyer. 1971. The trumpeter swan in Alaska. Wildlife Monographs. No. 26. 83 pp. (UAF)

This field study was started in the summer of 1957 and conducted with a varying degree of intensity through 1968. The purpose of the study was to determine the extent of the breeding range of trumpeter swans in Alaska, their numbers, breeding biology, habitat use, and responses to disturbance. Primary study areas were the lower Copper River system and the Kenai National Moose Range. Habitat types within the major areas of concern were lake-studded river valleys and lowlands dominated by spruce-hemlock or shrub and spruce-birch-aspen-muskeg communities. The activities of transporting personnel/equipment/material by air, land, and water and human disturbance produced documented direct impacts of collision with vehicles, active and passive harassment, and increased susceptibility to predation. On one occasion, a swan flew from its nest and deliberately flew into a float plane taxiing near the nest. Nesting swans on the Copper River delta were exposed to varied and more frequent levels of human activity than were two other areas within the lower Copper River system and had greater cygnet mortality than did nests in more isolated areas. Forced and rapid movement of cygnets from one body of water to another less secure, induced by human intrusion, tentatively appeared to be the greatest factor leading to higher cygnet mortality rates.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

McKelvey, R.W. 1979. Swans wintering on Vancouver Island, 1977-1978. Can. Field-Nat. 93(4):433-436. (UAF)

In this field study, an aerial survey of wintering swans on Vancouver Island, Canada, was conducted during February 1978 to determine numbers and distribution of swans for comparison with past surveys. Most swans were believed to be trumpeters, with lesser numbers of mute swans and a few whistling swans also present. Estuaries within coastal coniferous forest, similar to areas found in portions of Alaska, composed the habitat used by the swans. The activity of grazing produced a documented direct impact of attraction to an artificial food source. Swans were seen on dairy pastures adjacent to estuaries, apparently attracted to high nutrient forage grasses, and conflicts with farmers appear inevitable, should swan use of pasture land continue to increase.

Activity: grazing.

Impact: attraction to artificial food source.

McKelvey, R.W., M.C. Dennington, and D. Mossop. 1983. The status and distribution of trumpeter swans (Cygnus buccinator) in the Yukon. Arctic 36(1):76-81. (UAF)

This field study documents the number, distribution, productivity, and nesting habitat of trumpeter swans in the southern Yukon Territory, Canada, during the years 1978 through 1981. Habitat used by trumpeter swans was similar to that used by swans in Alaska, being generally small lakes within boreal forest. The activity of human disturbance produced documented direct impacts of active harassment and increased susceptibility to predation. Bald Eagles attempted two attacks on young swans after they were separated from the adults by the presence of the authors.

Activity: human disturbance.

Impact: harassment, active (hazing, chasing) or passive (noise, scent); parasitism and predation, increased susceptibility to.

Renken, R., M. North, and S.G. Simpson. 1983. Waterbird studies on the Colville River delta, Alaska: 1983 summary report. Draft. USFWS, Anchorage. (ADF&G-F, Habitat)

This paper reports general observations of waterbirds gathered incidentally during intensive field studies of swans, geese, and loons on the Colville River delta, Alaska, during May through August 1983. Observations included weather conditions, bird migration and nesting phenology, brant migration and nesting success, mammal activity, and aircraft overflights. Habitat within the study area is a combination of coastal tundra, lakes, and river delta. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. Except during sensitive periods (arrival, molt, staging), most birds did not seem to be disturbed by aircraft at altitudes greater than 100 m (328 ft). On three occasions [dates not provided] when single-engine aircraft flew overhead at 30-40 m (100-130 ft), a pair of tundra swans and 15 geese [species not specified] and other birds were flushed. On 9 August, when geese were staging in flocks, a helicopter at an altitude of 150 m (500 ft) and 1 km (0.6 mi) distant flushed all 130 white-fronted geese and half of the 29 Canada geese that were feeding and roosting in a tapped lake basin. Nearly all geese circled and returned to the site within 10 min. Pintails and mallards at the same site reacted only with alert postures.

Activity: transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Richey, R.A. 1981. Status of the trumpeter swan on the Kenai National Moose Range. Pages 20-21 in D.K. Weaver, ed. Proceedings and papers of the sixth trumpeter swan society conference. USFWS, TVA, Hennepin County Park Res. Dist. Maple Plain, MN. (ADF&G-F)

This field and review paper examines the human development-trumpeter swan conflicts on the Kenai Peninsula with data from 1957 through 1978. Habitat types within the Kenai National Moose Range are lake-studded lowlands timbered with spruce-birch-aspen forest and alpine forest and shrub and tundra communities. The activities of human disturbance and transportinf personnel/equipment/material by land, water, and air produced documented direct impacts of active and passive harassment. The activity of grading/plowing produced an indirect impact of passive harassment. Increased human presence and occupancy of the Kenai Peninsula has caused abandonment of some swan nesting sites. Some swans may have been forced into marginal nesting habitat to escape human disturbance. Wintering swans were common at the outlet of Skilak Lake until 1966 and may have left the area in response to human disturbance. The author states that the current trumpeter swan population on the Moose Range may well be determined by its insulation from disturbance.

Activity: grading/plowing; human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land; transport of personnel/equipment/material - water.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Shepherd, P.E.K. 1962. An ecological reconnaissance of the trumpeter swan in southcentral Alaska. M.S. Thesis, Washington State Univ. 168 pp. (UAF)*

This field study was conducted during the summers of 1957-1959 along the Copper River delta, the Martin River flats and the Bremner River in south-central Alaska. Trumpeter swan breeding biology, population estimates and dynamics were studied. Habitat types in the study area used by nesting swans were oceanic-influenced spruce-hemlock forest, willow-alder, and alder-*Elymus* communities containing suitable sized ponds. The activities of human disturbance and transport of personnel/equipment/material by air produced documented direct impacts of active and passive harassment and a potential impact of increased susceptibility to predation. Swans were observed aggressively displaying towards low-flying aircraft. A difference in cygnet survival between portions of the study area was suspected to have been caused by differing levels of human disturbance. Cygnets at times were led overland from 0.4-1.6 km (0.25-1.0 mi) from the natal pond after human disturbance. On several occasions, members of the brood were lost after extended movements, and such losses may have been due to predation. The author recommended that sanctuaries in high density breeding areas should be established and closed to human disturbance from May through August.

Activity: human disturbance; transport of personnel/equipment/material - air.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Slaney, F.F., and Co. 1973. Environmental effects assessment, Voyageur air cushion vehicle, Mackenzie Delta, N.W.T. Vol. II:Field Studies. Environmental Protection Service, Environment Canada. (UAF)

This field study was conducted during February, March, and August 1973 to assess the effects of a large air cushion vehicle (ACV) on the vegetation and wildlife of the Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, Canada. Reactions of tundra swans, black brant, white-fronted geese, greater scaup, and dabbling ducks to the ACV during August 1973 were recorded. Habitat within the study area was coastal tundra. The activity of transporting personnel/equipment/material by land produced documented direct impacts of harassment and collision with vehicles. Tundra swans flushed an average of 430 m (1,400 ft) [n = 17, range 69-823 m (225-2,700 ft)] ahead of the ACV. Larger groups tended to flush at greater distances than did solitary birds. A flock of 70 black brant became less tolerant of the ACV during repeated passes and increased their flushing distance from 225 m (725 ft) on the first pass to 1,190 m (3,900 ft) by the third pass. Brant displayed alertness to the sound of the ACV when the machine was out of sight and from 1.2-1.6 km (3/4-1 mi) distant. White-fronted geese flushed an average of 225 m (725 ft) [n = 5, range 91-550 m (300-1,800 ft)] from the ACV, with larger flocks generally flushing at greater distances. Dabbling ducks were relatively tolerant of the ACV, flushing an average of 83 m (270 ft) [n = 6, range 23-228 m (75-750 ft)] from the machine. One molting mallard was overrun on three occasions by the ACV with no apparent harmful effects. Greater scaup were relatively intolerant of the ACV, flushing at distances of 730 m (2,400 ft) and 1,200 m (3,900 ft). The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment. White-fronted geese, Canada geese, and dabbling ducks flushed in response to aircraft overflights at distances ranging from 60 m to 1,980 m (200 ft to 6,500 ft).

Activity: transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Sopuck, L.G., C.E. Tull, J.E. Green, and R.W. Salter. 1979. Impacts of development on wildlife: a review from the perspective of the Cold Lake project. LGL Limited, Edmonton, Alberta. Prepared for Esso Resources Canada Limited, Calgory, Alberta. 400 pp. (ADF&G-F)*

This review paper was developed as a step towards an assessment of the impact on wildlife of a proposed heavy oil plant at Cold Lake, Alberta, Canada. It reviews and synthesizes the literature that pertains generally to the impacts on wildlife of development in the boreal forest. The majority of the references cited were from the 1950's through the 1970's and were primarily from studies done in the northern United States, Alaska, and Canada. This paper addresses the impacts on wildlife of four major topics: alteration of water levels, clearing of vegetation, barriers to movement, and human disturbance. Habitat types present in individual studies were generally not described. Numerous species and species groups were discussed in this paper. Applicable species and species groups are discussed below.

Ducks. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of changes in aquatic vegetation, terrain destruction, alteration of prey base (molluscs), vegetation change to less preferred or useable species, water level and water quality fluctuations, and increased susceptibility to predation. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines and harassment. The activity of drilling produced a documented direct impact of passive harassment. The activities of transporting personnel/equipment/material by air and water produced documented direct impacts of active and passive harassment. The activity of human disturbance produced documented direct impacts of harassment. The activity of grading and plowing produced documented impacts of changes in aquatic vegetation, changes in water levels and water quality, terrain destruction, and vegetation damage/destruction due to mechanical removal. The activity of grazing produced a documented impact of vegetation destruction/damage due to grazing. The activities of draining and aquatic filling produced a documented impact of terrain alteration. The activity of clearing produced a documented impact of vegetation damage/destruction due to mechanical removal.

Geese. The activity of water regulation/withdrawal/irrigation produced documented direct impacts of increased susceptibility to predation and water level fluctuations. The activities of transporting personnel/equipment/material by air and land produced a documented impact of collision or electrocution by powerlines. The activities of drilling and transporting oil/gas/water by land produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced documented direct impacts of active and passive harassment. The activity of human disturbance produced a documented direct impact of harassment. The activity of transporting personnel/equipment/material by water produced a documented impact of harassment.

Trumpeter swans. The activity of transporting personnel/equipment/material by land produced a documented direct impact of collision or electrocution by powerlines. The activity of drilling produced a documented direct impact of passive harassment. The activity of transporting personnel/equipment/material by air produced a documented direct impact of harassment.

Bald Eagles. The activity of transporting personnel/equipment/material by land produced documented direct impacts of collision or electrocution by powerlines, and passive harassment. The activity of clearing and tree harvesting produced a documented impact of harassment and changes in vegetation composition. The activities of transporting personnel/equipment/material by air and water and human disturbance produced a documented direct impact of passive harassment. The activity of chemical application produced a documented impact of morbidity or mortality due to ingestion of chemicals.

Deer. The activity of clearing and tree harvesting produced documented direct impacts of attraction to an artificial food source, barriers to movement, and harassment and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of grading/plowing produced the documented direct impacts of attraction to an artificial food source and harassment. The activity of grazing produced the documented direct impact of harassment. The activity of human disturbance produced the documented direct impacts of barriers to movement, harassment, and increased susceptibility to predation (by dogs). The activity of transporting personnel/equipment/material by land produced the documented direct impacts of attraction to artificial food source, barriers to movement, collision with vehicles, increase in harvest level, and harassment.

Moose. The activity of blasting produced the documented direct impact of passive harassment. The activity of burning produced documented indirect impacts of vegetation damage or destruction due to fire and vegetation composition change. The activity of clearing and tree harvest produced the documented direct impact of barriers to movement and indirect impacts of vegetation composition change and vegetation damage or destruction due to mechanical removal. The activity of draining produced documented direct impacts of attraction to artificial food sources and barriers to movement and the indirect impact of vegetation composition change. The activity of human disturbance produced the documented direct impact of passive harassment. The activities of transporting oil/gas/water by land and personnel/equipment/material by land produced direct documented impacts of attraction to artificial food sources, barriers to movement, collision with vehicles, entrapment in impoundment or excavations, passive harassment, and an increase in the level of harvest. The activity of transporting personnel/equipment/material by air produced the documented direct impact of passive harassment.

Furbearers. The activity of blasting produced the documented direct impact of harassment. The activity of burning produced the documented indirect

impacts of addition of aquatic substrate materials and vegetation damage or destruction due to fire. The activity of clearing and tree harvest produced the documented direct impacts of attraction to an artificial food source, barriers to movement, alteration of prey base, and water level or water quality fluctuations, and the documented indirect impacts of destruction of aquatic vegetation, vegetation composition change to less preferred or useable species, and vegetation damage or destruction due to mechanical removal. The activity of human disturbance produced the documented direct impacts of harassment and increase in harvest level. The activity of transporting personnel/equipment/material by land produced the documented direct impact of harassment. The activity of water regulation/withdrawal/irrigation produced the documented direct impacts of increased susceptibility to parasitism and predation, and water level fluctuations, and the documented indirect impacts of destruction of or change in aquatic vegetation, and vegetation composition change to less preferred or useable species.

Activity: drilling; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: collision with vehicles or structures, or electrocution by powerlines; harassment, active (hazing, chasing) or passive (noise, scent).

Timm, D.E. 1981. Relationships between trumpeter swan distribution and cabins in the Susitna basin, Alaska. Pages 46-48 in D.K. Weaver, ed. Proceedings and papers of the sixth trumpeter swan society conference. USFWS, TVA and Hennepin County Park Reserve Dist., Maple Plain, MN. (ADF&G-F) *

The purpose of this field study was to quantify the relationships between trumpeter swan distribution and increased human disturbance resulting from cabin construction in the Susitna basin trumpeter swan habitat unit located to the west and north of Cook Inlet. This habitat unit is bounded by Redoubt Bay on the south, the Alaska Mountain Range on the west and north and the Talkeetna Mountain Range and Cook Inlet on the east. Habitat types within the area include spruce, birch, and aspen forest, lakes and muskeg-covered lowlands, large coastal river deltas, and numerous river valleys. The activities of human disturbance and transporting personnel/equipment/-material by land and air produced a documented direct impact of passive harassment. Conclusive results, produced by comparable aerial surveys conducted in 1968, 1975, and 1978, indicated that use of lakes by swans, particularly adults, decreased as cabins were constructed in areas used by swans. From the study, it appeared that swans were apt to be displaced when cabins occurred on the same lake where swans were found, regardless of the size of the lake. An overland separation of 0.8 km (0.5 mi) appeared to be an adequate buffer to human disturbance.

Activity: human disturbance; transport of personnel/equipment/material - air; transport of personnel/equipment/material - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Wiseley, A.N. 1974. Disturbance to snow geese and other large waterfowl species by gas-compressor sound simulation, Komakuk, Yukon Territory, August-September, 1973. Pages 1-36 in W.W.H. Gunn, W.J. Richardson, R.E. Schweinsburg, and T.D. Wright, eds. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biol. Rept. Ser., Vol. 27. (UAF)*

This field study was conducted from August 25 to September 28, 1973, on the arctic coastal plain at Komakuk, Yukon Territory. Objectives of the study were to determine the responses of staging and migrating snow geese to the sounds of a gas compressor sound simulator and to determine if geese would accommodate to this disturbance and feed in areas adjacent to the simulators. Habitat within the study area was arctic coastal tundra. Data on sex and age composition of snow goose flocks were not provided; flocks likely contained adult, subadult, and juvenile birds in family groups and other associations. The activity of transporting oil/gas/water by land (simulated) produced a documented direct impact of harassment. Noise from the sound simulator caused geese to break their flight formations, flare, gain altitude, increase calling behavior, increase or decrease their speed flight, and to land. Geese that were both vertically and horizonally nearer to the simulators reacted to sound disturbance more frequently than birds farther away. With one exception, feeding flocks of geese approached no closer than 800 m (2,625 ft) to the operating simulator's north side (where the most intense sound was directed). Flocks of geese fed within 100 m (328 ft) of the simulator when it was turned off during control periods. Some limited accommodation by feeding flocks of snow geese to the area of sound as evidenced by a series of "leapfrog" movements by some feeding flocks that brought them from well away from the sound simulator to a position somewhat closer. White-fronted and Canada geese and whistling (tundra) swans reacted to the sound simulator in a fashion similar to that of snow geese.

[Reviewer's note: The results of this study are comparable to the results of another similar study conducted the previous year by Gollop and Davis (1974). Gollop and Davis (1974) reported that snow geese only approached to within 2.5 km (1.6 mi) of the sound simulator, whereas geese approached to 800 m (2,625 ft) in this study. The author speculated that the decoys used to lure geese to the area of the simulators in the previous study (Gollop and Davis 1974) may have caused the geese to be more wary, that differences in topography may have caused differences in dispersion of sound from the simulator, and that the short time span of the previous study may not have been sufficient to allow any accommodation by the geese, all of which individually or collectively may account for the differences of the results of the two studies.]

Activity: transport of oil/gas/water - land.

Impact: harassment, active (hazing, chasing) or passive (noise, scent).

Human Use

Introduction

This portion of the present volume discusses the impacts of land or water use activities on the human use of fish and wildlife resources. The various human uses have been grouped into four categories: commercial fishing, noncommercial fishing, hunting, and trapping. There undoubtedly are impacts of land and water activities on nonconsumptive uses such as wildlife viewing, but they have not been included in this work. The many indirect impacts associated with impacts on the aforementioned human uses will not be considered in this section. Readers should be aware however, that impacts to human uses of fish and wildlife can initiate changes in economic conditions, social structures, and institutional organizations. Some of these ramifications are further explored in the human use narrative sections of the Alaska Habitat Management Guides. Although impacts to fish and wildlife species and their habitats also indirectly affect the human use of these resources such impacts are covered in the wildlife and fish impacts sections.

Similarly to the fish and wildlife impacts sections, the focus of this section is on impacts to human uses that are generated by activities associated with featured land or water uses or development types. The impacts categories for this section are listed in appendix F. Foremost among the criteria used to select references for this section was that a referenced impact must have been documented (i.e., observed) rather than merely suspected or inferred. Because predevelopment environmental and socioeconomic impact statements have become a prudent, if not required, part of the development process, there exists a huge body of impacts literature dealing exclusively with the potential impacts of proposed developments. One would think that the recognition of potential impacts would be derive from past experience and therefore have been confirmed by documentation. With respect to human use impacts such documentation has rarely been the case. Instead, recognition of potential impacts to human use seems to be, in many cases, a matter of "common sense" rather than of documented past experience. Furthermore, postdevelopment studies that include an examination of human use impacts are exceptional rather than usual. One can but hope that this data gap is at least in part due to the effectiveness of mitigative planning resulting in there being few impacts to report.

The activity categories identified for the fish and wildlife impacts sections (table 1, General Introduction) are identical to those identified for human use impacts, with one exception. Whereas it is likely to be the clearing, filling, or other activities associated with road construction that impact habitats and/or species, the completed road itself presents an additional potential for impacting human use through changes in access to use areas, changes in available transportation options, and increased competition for resources. To address this, a new activity category, Establishment of roads/access corridors, was added for consideration with respect to human use.

Because human uses are less influenced by environmental parameters than is fish and wildlife distribution, for example, the applicability of a reference to a specific region of Alaska was of less concern here than for species impacts volumes. References documenting human use impacts in Alaska, Canada, and the continental United States were determined to be broadly applicable to all regions of Alaska and have been included. References that provided information about suspected or potential impacts are on file but will not be included here; however, suspected impacts are denoted as "?" in tables 1 through 3.

The tables below indicate types of human use affected by various activities (table 1), the impacts of activities on types of human use (table 2), and the impacts to human uses associated with various activities (table 3). The first subsection provides citations to references dealing with each impact category under each human use type and serves as a guide to the annotated bibliography that follows in the next subsection.

Table 1. Types of Human Use of Fish and Wildlife That Are Affected by Land/Water Use Activities

Activity	Fishing - commercial	Fishing - noncommercial	Hunting	Trapping
Blasting				
Burning				
Channelizing				
Chemical Application				
Clearing/Tree Harvest	?	X	X	X
Draining				
Dredging	X			
Drilling	X	X	X	X
Establishment of Roads/Access Corridors *			X	
Fencing				
Filling - Aquatic	?	X		
Filling - Terrestrial				
Grading/plowing		X		
Grazing				
Human Disturbance		X	X	
Log Storage and Transport		X		
Netting				
Processing Lumber/Pulp	?	X		
Processing Minerals/Gravel		X		
Processing Geothermal Energy				
Processing Oil/Gas	X	X	X	X
Sewage Disposal	X	X		
Solid Waste Disposal				
Stream Crossing - Structures				
Stream Crossing - Fords		X		
Transport of Oil/Gas/Water - Land				
Transport of Oil/Gas/Water - Water	X	X		
Transport Personnel/Equipment/Material - Air				
Transport Personnel/Equipment/Material - Land				
Transport Personnel/Equipment/Material - Water	X			
Water Regulation/Withdrawal/Irrigation				

X - Documented impact (see section II. of text).
? - Potential impact.
* - Activity applicable to human use impacts only - see introduction for explanation.

Table 2. Impacts of Land/Water Uses on Types of Human Use of Fish and Wildlife

Type of Human Use \ Impact	Reduced Access - Legal Status	Reduced Access - Disturbance	Disturbance of Use Sites	Increased Competition	Interference With Harvest Gear	Change in Resource Distribution	Change in Timing of Resource Availability	Change in Transportation Options	Demographic-Economic Change	Change in Resource Quality
Fishing - commercial		X	X	X	X				X	X
Fishing - noncommercial	X	X	X	X				X	X	X
Hunting	X	X	X	X		?		X	X	
Trapping	X	X				?		?		

X - Documented impact (see section II. of text).
? - Potential impact.

Table 3. Impacts to Human Use of Fish and Wildlife Associated With Land/Water Use Activities

Impact \ Activity	Blasting	Burning	Channelizing	Chemical Application	Clearing/Tree Harvest	Draining	Dredging	Drilling	Establishment of Roads/Access Corridors *	Fencing	Filling - Aquatic	Filling - Terrestrial	Grading/Plowing	Grazing	Human Disturbance	Log Storage and Transport	Netting	Processing Lumber/Pulp	Processing Minerals/Gravel	Processing Geothermal Energy	Processing Oil/Gas	Sewage Disposal	Solid Waste Disposal	Stream Crossing - Structures	Stream Crossing - Fords	Transport of Oil/Gas/Water - Land	Transport of Oil/Gas/Water - Water	Transport Personnel/Equipment/Material - Air	Transport Personnel/Equipment/Material - Land	Transport Personnel/Equipment/Material - Water	Water Regulation/Withdrawal/Irrigation
Reduced Access - Legal Status								X	X				X						X		X										
Reduced Access - Disturbance					X		X	X	X				X						X		X										
Disturbance of Use Sites					X			X	X		X		X			X			X		X	X			X		X				
Increased Competition									X						X			X			X										
Interference With Harvest Gear								X																			X			X	
Change in Resource Distribution	?				?																										
Change in Timing of Resource Availability																															
Change in Transportation Options					X				X																						
Demographic-Economic Change									X												?										
Change in Resource Quality								X													X	X					X				

X - Documented impact (see section II. of text).
? - Potential impact.
* - Activity applicable to human use impacts only - see introduction for explanation.

IMPACTS CITATIONS--HUMAN USE OF FISH AND WILDLIFE

This section consists of lists of citations to the annotated references about documented impacts of human uses and development types on human uses of fish and wildlife resources. Each citation refers to an annotation in the following section, Annotated References to Impacts. The organization of this section is by type of human use overall and by impacts categories within each human use type. Impacts categories for which no pertinent references were located for a given human use have been omitted.

A. Fishing-Commercial

Reduced access to use sites due to disturbance

Kumpf 1977
Nelson & Sabine 1981
St. Amant 1971
Zinn 1971

Disturbance of use sites

Hunter 1978
Nelson & Sabine 1981
Straughan 1971

Increased competion for resources

No documentation located

Interference, damage, or loss of harvest gear

Hunter 1978
Nelson & Sabine 1981
Panitch 1975
St. Amant 1971

Change in community size, demography or economic base

Community and Systems Analysis 1983

Change in the quality of a resource

Idler n.d.
Kumpf 1978
St. Amant 1971
Zinn 1971

B. Fishing-Non Commercial

Reduced access to use sites due to a change in land status

Pedersen 1982

Reduced access to use sites due to disturbance

Pedersen 1982
Tebo 1956
Zinn 1971

disturbance of use sites

Bartsch 1960
Hunter 1978
La Perriere 1983
Tebo 1956
Townsend 1983

Increased competition for resources

Pedersen 1982
Schwege 1980

Change in available transportation options

Community & Systems Analysis 1983

Change in community size, demography, or economic base

Community & Systems Analysis 1983

Change in the quality of a resource

Idler n.d.
Kumpf 1977
St. Amant 1971
Zinn 1971

C. Hunting

Reduced access to use sites due to a change in legal status

ADF&G 1984

Reduced access to use sites due to disturbance

ADF&G 1984

Disturbance of use sites

Ellanna & Sherrod (in press)
George & Kookesh 1983

Increased competition for resources

Ellanna & Sherrod (in press)
George & Kookesh 1983
Goodwin 1975

Change in available transportation options

Community & Systems Analysis 1983

Change in community size, demography, or economic base

Community & Systems Analysis 1983

D. Trapping

Reduced access to use sites due to a change in legal status

ADF&G 1984

Reduced access to use sites due to disturbance

ADF&G 1984

ANNOTATED REFERENCES TO IMPACTS

The annotated bibliography contains only references that discuss documented impacts to human use of fish and wildlife. All annotations are listed alphabetically by author. Activities and impacts that were discussed in the reference and pertain to human use are listed below each annotation. The abbreviations in parentheses [e.g., (UAF)] refer to the physical location of the reference. Abbreviations are explained in appendix G.

ADF&G. 1984. Alaska game regulations. Alaska Board of Game, Juneau, Ak. 77 pp. (ADF&G-A,F)

Several instances of areas closed to hunting as a result of development activities are reflected in Alaska's game regulations. Closed or restricted areas surrounding oil field development activities on the North Slope, along the Dalton Highway corridor, and near the Healy/Lignite coal-mining operation are specific examples of hunting areas lost to or restricted by development activities. In general, closed or restricted areas are established to enhance the safety of both industry personnel working at the development sites and the hunting public who could be endangered by a variety of development-related hazards (ADFG, Dick Bishop, personal communication).

Activity: establishment of roads/access corridors, processing oil and gas, processing minerals

Impact: reduced access to use sites due to a change in legal status, reduced access to use sites due to disturbance

Bartsch, A.F. 1960. Settleable solids, turbidity, and light penetration as factors affecting water quality. Pages 118-127 in C.M. Tarzwell, ed. Transaction of the second seminar, biological problems in water pollution, U.S. Dept. Health, Education and Welfare, Cincinatti.

This paper reviews the damaging effects of settleable solids and turbidity on water quality and stream biology. Silt, logging debris, industrial waste, and sewage are cited as major causes of turbidity. Siltation is regarded as one of the most important factors imparing otherwise desirable fishing waters.

Some of the biological effects of turbidity on stream fauna are discussed. Of particular interest with respect to human use impacts is the author's conclusion that chronically turbid waters are lost as fishing areas because 1) they are less aesthetically pleasing places for fishing, and 2) fishing success is low because of the reduced ability of fish to see the lure.

Activities: clearing/tree harvest, dredging, filling and pile-supported structures (aquatic), grading/plowing, processing minerals/gravel, sewage disposal

Impact: disturbance of use sites

Community and Systems Analysis. 1983. Hydaburg and Haida in change: a social impact assessment of the Hydaburg-Natzuhini road connection on the community of Hydaburg, Alaska. Prepared for the City of Hydaburg, AK. 60 pp. (ADF&G-J)

This paper assesses the social and cultural effects of providing road transportation to a small community. It uses the results of prior case studies at Craig and Skagway to predict changes in the demand for public services, population increases, and commercial development and concludes that increased wage employment opportunities will likely result in a decreased reliance on subsistence activities and commercial fishing.

Activity: establishment of roads/access corridors

Impact: change in available transportation options, change in community size, demography, or economic base

Ellanna, L.J., and G. Sherrod. In preparation. Timber management and fish and wildlife utilization in selected southeast communities: Klawok, Prince of Wales Island. Tech. Paper No. 126. ADF&G, Div. Subsistence, Juneau.

This report analyzes some of the socioeconomic impacts of logging activities on the Southeast Alaska community of Klawok. In particular, the impacts of clear-cutting and construction of the Hollis-Klawok logging road on the use of fish and wildlife are examined. Study results show that following road construction and logging activities there was an initial rapid increase in deer hunting along the road corridor, with good hunter success reported. However, hunter success and use of the road area by local hunters was shown to decline significantly after several years because of increased competition by outside hunters and habitat changes such as reforestation and natural succession that were not conducive to deer hunting.

Activity: clearing/tree harvest, establishment of roads/access corridors, human disturbance

Impact: disturbance of use sites, increased competition

George, G.D., and M.A. Kookesh. 1983. Angoon deer hunting, 1982. Tech. Paper No. 71. ADF&G, Div. Subsistence, Juneau.

This report examines historic and contemporary deer hunting practices in the Southeast Alaska community of Angoon. Logging activities are cited as the major cause for hunter avoidance of areas previously used for deer hunting. In looking at areas used for deer hunting over time, 39.3% of hunters surveyed reported they had stopped hunting in some areas because of logging, the appearance of nonlocal hunters, an increase in local hunters, or the distance from Angoon. Logging activities have the immediate effect of disturbing use sites. Human disturbance in the form of increased nonlocal and local hunters also appears to play a role in making use areas unattractive to some hunters through increased competition.

Activity: clearing/tree harvest, human disturbance

Impact: disturbance of use sites, increased competition

Goodwin, J.G., Jr. 1975. Big game movement near 500KV transmission line in Northern Idaho. Bonneville Power Administration, Engineering and Construction Division, Portland, OR. 56 pp. (GD)

This report documents increased hunting activity along transmission line right-of-way clearings and access roads, due to increased access and improved animal forage. (Increased access to hunting areas can be viewed as an enhancement or an impact, depending on management schemes for target species and the presence or absence of conflicting user groups.)

Activity: clearing, establishment of roads/access corridors

Impact: increased competition for resources, change in available transportation options

Hunter, G. 1978. Fisheries and Oil. Pages 108-112 in J. Button, ed. The Shetland way of oil: reaction of a small community to big business. Thuleprint Ltd., Sandwick, Shetland. 144 pp. (SD-F)

A brief review of the impact of Shetland offshore oil development on the local commercial fishery, this report documents destruction of productive fishing grounds by the construction of an underwater pipeline and damage to trawl gear from debris left behind by the oil industry.

Activity: drilling, processing oil and gas

Impact: disturbance of use sites, interference with harvest gear

Idler, D.R. Nd. Effects of pollutants on quality of marine products and effects on fishing. Pages 535-541 in Marine pollution and sea life. For FAO by Fishing News (books) Ltd., London.

This paper is primarily concerned with tainting--the undesirable modification of texture, taste, or color of marine products induced by exposure to or ingestion of pollutants. It identifies worldwide sources of pollutants and examines the potential threat to marine organisms and includes numerous citations from Canadian case studies. The importance and sensitivity of estuarine and coastal waters to pollution is stressed, as are the particular sensitivities of several fish and shellfish species.

Activity: processing oil and gas, drilling, sewage disposal, transport oil/gas/water-water

Impact: change in quality of resource

Kumpf, H.E. 1977. Economic impact of the effects of pollution on the coastal fisheries of the Atlantic and Gulf of Mexico regions of the United States of America. FAO Fisheries Tech. Pap. No. 172. Rome. 71 pp. (HD)

This report reviews and evaluates the economic impact of pollution on the fisheries of the Atlantic and Gulf of Mexico coasts. Pollution sources include production of oil and gas, dredging, and effluent disposal. Documented impacts include habitat deterioration and closure of shellfishing areas for health reasons. Quantification of impacts by dollar value is attempted. Both negative and positive impacts are discussed.

Activity: dredging, processing oil and gas, sewage disposal

Impact: reduced access to use areas due to disturbance, change in quality of resource

La Perriere, J.D. 1983. An ecosystem approach to the effects of placer mining on streams of Interior Alaska (review-annual report to USEPA). Alaska Cooperative Fishery Research Unit, Univ. Alaska, Fairbanks. (HD)

A progress report addressing some of the differences in water quality between two forks of Birch Creek, one with active mining operations and one without. The report correlates higher turbidity and other effects of placer mining with decreased participation in sportfishing.

Activity: processing of minerals, stream crossing-fords, grading/plowing

Impact: disturbance of use sites

Nelson, J.G., and J. Sabine. 1981. The Scottish and Alaskan offshore oil and gas experience and the Canadian Beaufort Sea. Canadian Arctic Resources Committee, Ottawa. 155 pp. (SD-F)

This book assesses the relationships between local, state, and senior government agencies and the oil industry in Scotland and Alaska. Suggestions and recommendations are made as a result of those experiences on how to proceed with petroleum development in the Canadian arctic. It documents conflicts in the Shetlands between oil development and the fishing industry. Conflicts cited are loss of fishing gear, physical displacement of fishermen on the fishing grounds by oil industry facilities, and destruction of once-productive fishing grounds by the construction of an underwater pipeline.

Activity: drilling, processing oil and gas

Impact: interference with harvest gear, disturbance of use sites, reduced access to use sites due to disturbance

Panitch, M. 1975. Offshore drilling: fishermen and oilmen clash in Alaska. Science (189):204-206. (UAF)

This article summarizes the 1975 controversy surrounding planned offshore oil development in a biologically rich area of lower Cook Inlet used heavily by commercial fishermen. It discusses the unusually high biological productivity of Kachemak Bay as a breeding ground for fish and shellfish species and documents the lethal effects of oil pollution on larval shellfish. It also documents gear loss and gear damage caused by increased marine traffic associated with oil exploration activities.

Activity: drilling, rocessing oil and gas, ransport of personnel/equipment/materials-water, transport of oil/gas/water-water

Impact: interference with harvest gear

Pedersen, S. 1982. Report on fishery regulation 5AAC 01.125. ADF&G, Div. Subsistence, unpubl. rept. (SD-F)

Fishery regulation 5AAC 01.125 was adopted in 1975 and resulted in the closure of a large coastal area in the vicinity of the Prudhoe Bay/Kuparuk oil development area to all subsistence fishing. Increased competition from a large influx of oil workers in this area is cited as part of the justification for this regulation, which represents a documented example of a fishing area lost to development activity. The history of the regulation and attempts to modify it are reviewed along with an overview of subsistence fishing activities that traditionally and recently took place along this stretch of the Beaufort Sea coast.

Activity: drilling, processing oil and gas

Impact: increased competition for resources, reduced access to use sites due to land status, educed access to use sites due to disturbance

Schwige, D.C. 1980. Influence of forest and rangeland management on anadromous fish habitat in western North America: processing mills and camps. Gen. Tech. Rept. PNW-13. USDA:Forest Service. (FSL)

This report documents the impacts of logging camps on sportfishing. Evidence suggests that logging camp personnel are responsible for unusually heavy fishing pressure, resulting in localized depletion of fish runs. (This is viewed as a human use impact where competing user groups are involved.)

Activity: clearing/tree harvest, human disturbance, processing lumber/pulp

Impact: increased competition for resources

St. Amant, L.S. 1971. Impacts of oil on the Gulf Coast. Pages 206-218 in Transactions of the 36th North American wildlife and natural resources conference. Wildlife Management Institute. (UAF)

This paper reviews the impacts of extensive oil development off the coast of Louisiana to fish and wildlife populations. It documents the displacement of fishermen, particularly shrimp trawlers, by the placement of offshore oil equipment and facilities. It also documents the loss of fishing gear and discusses the sensitivity of some shellfish to long-term tainting from relatively low levels of exposure to oil pollution.

Activity: drilling, processing oil and gas, transport of personnel/equipment/materials-water, transport of oil/gas/water-water

Impact: interference with harvest gear, reduced access to use sites due to disturbance, change in quality of resource

Straughan, S. 1971. Oil pollution and fisheries in the Santa Barbara Channel. Pages 245-254 _in_ Biological and oceanographical survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. 1. (HD)

Reduced catches of fish were reported following the 1969 oil spill in the Santa Barbara Channel. This report presents data that suggest that the reduction in fish catches was probably due to technical problems associated with fishing in oily water rather than to a devastation of fish stocks.

Activity: transportation of oil/gas/water-water

Impact: disturbance of use sites

Tebo, L.B., Jr. 1956. Effects of siltation on trout streams. Pages 198-202 in Proceedings of the Society of American Foresters.

This article documents the reduced use of an area by trout fishermen following logging and logging road construction along a stream channel. These development activities caused significant alteration of the stream channel, siltation, and the accumulation of debris making access and passage along the stream difficult for fishermen. The biological effects of siltation and logging debris on trout-spawning success and food supply are briefly discussed.

The physical effects of siltation caused the stream to become a shallow, muddy, slow-moving stream that was not conducive to trout fishing. A 40% decline in the number of fishermen using the impacted area was recorded 3 yr following development activities.

Activity: clearing/tree harvest, filling-aquatic, channelizing, grading/plowing, log storage/transport

Impact: disturbance of use site, reduced access due to disturbance

Townsend, A.H. February 2, 1983. Memo to Bruce Baker: Sportfishing-placer mining-Chatanika River. ADF&G, Div. Habitat, Fairbanks. (HD)

This memo documents the existence of turbid discharges from placer mining operations on the Chatanika River and correlates this with the declining popularity of the river for recreational fishing. A 55% decrease in sportfishing on this river is documented from 1978 to 1979.

Activity: processing of minerals/gravel, stream crossing-fords, grading/plowing

Impact: disturbance of use sites

Zinn, D.J. 1971. The impacts of oil on the east coast. Pages 188-204 in Transactions of the 36th North American wildlife and natural resources conference. Wildlife Management Institute. (UAF)

This article provides an overview of the biological and economic productivity of the Atlantic coastal zone in terms of fish and wildlife resources. Shellfish are reported to be particularly sensitive to long-term tainting by oil pollution, and several examples of oil spills resulting in the closure of shellfishing areas to sport and commercial shellfishers are cited. Some areas were closed for as long as 2 yr.

Activity: processing of oil and gas, drilling, transport of oil/gas/water-water

Impact: change in quality of resource, reduced access to use sites due to disturbance

Appendices

A. Directory of Reviewers and Contributors

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B. Land and Water Uses and Development Types

Commercial fishing*
Fire management
Geothermal energy development
Grain and hay farming
Harbors and shoreline structures
Offshore prospecting and mining
Oil and gas development
Pipelines
Placer mining
Red meat and dairy farming
Seafood processing
Settlement
Silviculture and timber processing
Strip and open pit mining
Transmission corridors
Transport--air, rail, and road
Underground mining
Water development

*Impacts to nontarget species, such as marine mammals and seabirds, only.

C. List of Activities

Blasting
Burning
Channelizing waterways
Chemical application
Clearing and tree harvest
Draining
Dredging
Drilling
Fencing
Filling and pile-supported structures (aquatic and wetland habitats)
Filling (terrestrial)
Grading/plowing
Grazing
Human disturbance
Log storage/transport
Netting
Processing geothermal energy
Processing lumber/kraft/pulp
Processing minerals (including gravel)
Processing oil/gas
Sewage disposal
Solid waste disposal
Stream crossing - fords
Stream crossing - structures
Transport of oil/gas/water - land, ice
Transport of oil/gas/water - water
Transport of personnel/equipment/material - air
Transport of personnel/equipment/material - land, ice
Transport of personnel/equipment/material - water
Water regulation/withdrawal/irrigation

For definitions, see appendix D

D. Definitions of Activities

Blasting

Blasting refers to the use of high explosives (e.g., dynamite, TNT, ammonium nitrate, plastic explosives) to excavate material (e.g., rock, ice, soil, or tree stumps) or the use of explosives or nonexplosive devices (e.g., airguns, vibroseis) to create a shock wave sufficient to be monitored by geophones (on land) or hydrophones (in water). Airguns use compressed air to create a shock wave for seismic work in water. "Vibroseis" uses a small gas explosion to create a shock wave for seismic work on land. Blasting is often used during the exploratory phase (e.g., seismic exploration during oil/gas development or mining) and/or the construction phase (e.g., tunnel excavation or riprap production during highway construction, pipeline ditch excavation in rock or frozen substrate) of many kinds of development. Most high explosive blasting on land requires drilling. See the activity of Drilling for impacts from seismic and construction drilling.

Typical impacts:

- Harassment noise of explosions, equipment
- Entrapment (e.g., in blasted ditches, quarries)
- Mechanical destruction of vegetation
- Death or injury from shock waves (e.g., to marine mammals or seabirds from underwater blast)
- Changes in sedimentation rates, turbidity, suspended solids

Burning

Burning refers to the controlled use of fire in a predetermined area for the purpose of returning or maintaining vegetation at an early successional stage (i.e., at a stage where grasses, shrubs, and saplings are the predominant forms of vegetation). Major uses of controlled burns include inhibition of woody plant growth for the purpose of maintaining open land cover, manipulation of wildlife habitat to improve the food and shelter requirements of targeted species (e.g., moose), reduction of wildfire hazards, and disposal of slash from cutover areas.

Typical impacts:

- Harassment

- Vegetation damage/destruction due to fire
- Changes in water temperature, dissolved oxygen, or pH (e.g., due to runoff from burned areas or destruction of riparian vegetation)
- Changes in biological oxygen demand, nutrient loading in surface waters
- Changes in sedimentation rates, turbidity, and suspended solids levels in surface waters
- Barriers to movement because animals avoid large areas without cover

Channelizing Waterways

Channelizing waterways refers to the modification of an existing stream, river, canal, or other flowing water course for the purpose of realigning the flow of water. Channelizing generally results in the physical alteration of bottom substrate, channel geometry, or configuration. Modifications generally include one or more of the following: 1) widening or deepening the channel, 2) installing structures (e.g., dikes or bank stabilization structures, 3) removing structures (e.g., snags or large debris), 4) eliminating channel meanders, 5) creating uniform substrate conditions, or 6) creating a new stream channel (e.g., diversion ditches for irrigation or for other purposes). Closely associated activities not included under channelizing are the excavation of substrate materials for the purpose of maintaining water transportation routes and boat harbors (see Dredging), the installation of dikes, gabions, jetties, etc., in estuarine environments (see Filling and pile-supported structures [Aquatic and Wetland Habitats)], construction of low water crossings (see Stream Crossings-Fords), and creating ditches in wetlands or shallow lakes for the purpose of draining them (see Draining).

Typical impacts:

- Changes in substrate composition
- Barriers to movement
- Vegetation damage or destruction due to mechanical removal
- Changes in flow or water level
- Harassment
- Changes in water temperature (e.g., reduction of stream cover)
- Changes in sedimentation rates, turbidity, suspended solids

Chemical Application

Chemical application refers to the purposeful spreading or placing of any chemically active substance upon lands or waters or within or around structures. Agriculture and silviculture account for the majority of chemical applications to land and water, although highway maintenance is also important. Substances that markedly change the physical properties of that to which they are applied (e.g., carbon black or salt on ice or snow) are also included, as is storage of chemicals. Chemicals used to kill vegetation (herbicides) are also included in this activity. Petroleum and its fractions and products are included (e.g., oiling of roads for dust control), except for spills, which are included under the headings of Processing of oil/gas or Transport of oil/gas/water-land, ice. Other chemical applications, which are excluded here, include industrial pollution of air and water (considered under the Processing of lumber, kraft, and pulp; Processing of minerals; and Processing of oil/gas), and disposal of chemicals in solid waste or sewage (considered under Solid waste disposal or Sewage disposal).

Typical impacts:

- Attraction of wildlife to artificial food source (e.g., ungulates to road salt or urea fertilizer)
- Changes in biological oxygen demand (BOD), nutrient loading (e.g., fertilizer)
- Changes in chemical composition of water (e.g., herbicides, pesticides)
- Changes in terrestrial or aquatic vegetation, including algae (e.g., eutrophication)
- Morbidity or mortality due to ingestion of or contact with petroleum, petroleum products, or other chemicals (e.g., raptors, from chlorinated hydrocarbons)
- Vegetation damage or destruction due to contact with petroleum, petroleum products, or chemicals (e.g., road salt)

Clearing and Tree Harvest

Clearing and tree harvest refers to the removal of trees or other vegetation, either partially or entirely, by mechanical means. Skidding logs within cutting areas is included in this activity. Clear-cutting and selective tree harvest is often associated with other activities such as construction of access roads and timber processing facilities (see the activity categories Grading and plowing, and Processing lumber, kraft, or pulp). Clearing of vegetation prior to new construction projects such as roads is included in Clearing and tree harvest, but maintenance clearing of corridors for pipelines, electric power transmission lines, railroads, and highway rights-of-way by mechanical means is included in the activity category Transport of personnel/equipment/material by land, ice. The use of herbicides to clear vegetation is included in the activity category of Chemical application.

Typical impacts:

- Barriers to movement (e.g., slash piles and downed trees)
- Change in harvest level (e.g., increase due to improved access)
- Changes in dissolved oxygen (DO), pH, salinity, temperature (e.g., increased sunlight penetration to streams)
- Changes in flow or water level (e.g., accelerated runoff)
- Changes in terrestrial or aquatic vegetation, including algae
- Entanglement in terrestrial debris (e.g., slash)
- Harassment (e.g., from noise of machinery and people)
- Vegetation damage or destruction due to mechanical removal, contact with chemicals, or hydraulic or thermal erosion or deposition
- Vegetation composition, change to less preferred or useable species or successional stages

Draining

Draining refers to the intentional reduction of water content from shallow ponds or soils. Water content generally is reduced by recontouring (also see the activity of Grading/plowing) the surface area of concern and/or introducing highly porous soil materials to the area that will facilitate water flow away from the site. Open ditches or covered gravel trenches designed to accommodate gravitational flow ("french drains") are common techniques employed in drainage operations. Drainage of wet soil areas generally is undertaken when a land use is planned in a chronically wet area (e.g., draining wetlands to increase land available for farming).

Typical impacts:

- Harrassment
- Vegetation composition change to a less preferred or useable species (e.g., from wetland to upland vegetation)

- Water level or water quality fluctuations in surface waters

- Changes in sedimentation rates, turbidity, and suspended solids in surface waters

Dredging

Dredging refers to excavation within aquatic or wetland habitats. Dredging is often conducted in relation to shoreline alteration projects, site preparation and/or maintenance of ports, harbors, and marine transportation routes, and for the purposes of sand and gravel extraction from aquatic habitats, gravel extraction from floodplains, and extraction of borrow or fill materials. Examples of equipment used for dredging include suction dredges, backhoes, bucketlines, clam shovels, and draglines. Dredging of canals for transport, irrigation, or channelizing of waterways is included in the activity category Channelizing waterways. Excavation of terrestrial habitat adjacent to aquatic habitat (e.g., for road construction) is included in the activity categories of Grading and plowing and Blasting. Such excavation during placer mining is considered in Processing of minerals. Dredging of ditches for the purpose of draining a marsh or shallow lake is included in Draining.

Typical impacts:

- Changes in substrate composition

- Vegetation damage or destruction due to mechanical removal or material overlay

- Changes in sedimentation rates, turbidity, suspended solids

- Changes in chemical composition of water

- Changes in flow or water level (e.g., wetlands)

Drilling

Drilling refers to the use of a portable drill mounted on a mobile vehicle (e.g., ship, Nodwell, truck) or a stationary drill assemblage that is usually supported on a gravel, ice, or concrete pad or steel platform and that is employed to drill into the earth's surface to prepare shot holes for blasting, sample the substrate (soil, rock, ice, or water), or extract liquified material (e.g., oil, gas, steam, water). Shothole drilling, substrate sampling, road construction, and seismic exploration are usually conducted from portable equipment and often are part of the exploratory phase of several types of development. Oil, gas, and geothermal exploratory and production drilling are often conducted from stationary pads. Stationary drilling rigs often are accompanied by auxiliary facilities such as drilling towers, pits to store recirculating drilling mud, pipe and drill stem storage areas, and occasionally camps for the drill crew.

Typical impacts:

- Harassment
- Interference with intraspecies communication (e.g., offshore drilling)
- Morbidity or mortality due to ingestion of petroleum products or chemicals (e.g., some drilling mud compounds)
- Vegetation damage due to mechanical removal
- Changes is chemical composition of water (e.g., heavy metals)
- Changes in sedimentation rates, turbidity, suspended solids

Fencing

Fencing refers to the construction and maintenance of barriers designed to prevent or inhibit the movement of humans or animals from one place to another. Structures designed as visual barriers (e.g., landscape fences, highway medians) or other barriers such as snow fences, which incidentally inhibit movement of animals, are also included. Fences extensive enough to act as barriers to wildlife are usually associated with agricultural projects or major highways.

Typical impacts:

- Barriers to movement
- Entanglement in terrestrial structures, such as wire fences

Filling and Pile-Supported Structures (Aquatic and Wetland Habitats)

Aquatic filling refers to the deposition or placement of material (e.g., gravel, rock, soil, concrete, wood, steel) into aquatic and wetland habitats for the purpose of making the habitat suitable for constructing various types of structures or water impoundments. Examples of structures include buildings, drilling islands, breakwaters, jetties, groins, bulkheads, revetments, dikes, and causeways. Filling also includes pile-supported structures, such as bridges, piers, and docks. Filling of aquatic and wetland habitats during the construction phase of various types of water impoundments is included here (e.g., hydroelectric dams, wastewater treatment, water cooling ponds, or ponds used for aquacultural purposes). After impoundments have been constructed and are being filled with water, they are considered under the activity category of Water regulation/withdrawal/irrigation. Deposition of fill, including nonsewage waste and drilling muds, for the purpose of disposal is not included here (see Solid waste disposal) except in cases where waste materials are used for preparation of sites for construction of the structures indicated above.

Typical impacts:

- Physical barriers to movement
- Changes in substrate composition
- Changes in the chemical composition of water
- Changes in flow or water level, entrapment
- Changes in sedimentation rates, turbidity, suspended solids
- Changes in dissolved oxygen, temperature, pH, salinity

Filling (Terrestrial)

Filling refers to the intentional addition of soil, rock, or other material to a defined land area. Filling normally is undertaken to improve land surface features for a selected land use such as construction of roads, pipelines, or building complexes. This activity does not include filling in open-water areas and wetlands or disposal of spoil or other solid wastes. These activities are discussed under the activity categories of Filling and pile-supported structures (Aquatic and Wetland Habitats), and Solid waste disposal, respectively. Spoil, however, that is used specifically to fill an area for some defined purpose, is included here.

Typical impacts:

- Harrassment
- Vegetation damage/destruction due to mechanical removal or material overlay
- Water level and quality fluctuations (e.g., ponding of sheet runoff uphill from the fill)
- Terrain alteration or destruction

Grading and Plowing

Grading and plowing are interrelated activities that involve the alteration or disruption of terrestrial substrates. Plowing is an agricultural practice and involves breaking and turning of soil such that the vegetative cover is eliminated and the root or moss mat is disrupted. Growing of agricultural crops such as grains or vegetables is also included in this activity. Grading includes the disruption of substrate strata beneath the soil surface and may result in the alteration of the contours of land by movement of soil, subsoil, or other substrate within a localized area. Typical equipment used for grading includes scrapers, bulldozers, backhoes, draglines, or clam shovels. Grading is used during several developmental activities, including road construction and maintenance, preparation of sites for building structures, and surface mining. Grading usually involves some filling as well as excavating, but if extensive filling is involved, the activity categories of Filling (aquatic and wetland habitats) and pile-supported structures (aquatic), Filling (terrestrial), or Solid waste disposal should be consulted instead. Grading that facilitates drainage by removing excess soil water is considered under the activity category of Draining. The removal of soil or substrates in floodplains and wetlands is considered under the activity category of Dredging.

<u>Typical impacts</u>:

° Barriers to movement (e.g., large openings lacking cover)

° Changes in flow or water level

° Changes in sedimentation rates, turbidity, suspended solids (e.g., runoff from hydraulic erosion or fugitive dust)

° Changes in substrate composition and location

° Entrapment in excavations

° Harassment

° Terrain alteration or destruction

° Vegetation damage or destruction due to mechanical removal or material overlay

Grazing

Grazing refers to the introduction of animals onto lands for the purpose of feeding on the vegetation. The land may provide all or a portion of the feed, for a few days or throughout the year. Other activities often associated with open range or improved pasture grazing that should be referred to when considering the impacts of grazing include Fencing, Chemical application, Clearing and tree harvest, Grading and plowing, and Water regulation/withdrawal/irrigation.

Typical impacts:

- Changes in biological oxygen demand (BOD), nutrient loading (e.g., from grazed areas with an accumulation of livestock manure)
- Changes in flow or water level
- Changes in substrate composition and location (e.g., stream bank breakdown and accelerated erosion)
- Changes in sedimentation rates, turbidity, suspended solids
- Attraction to artificial food source (e.g., bears to cattle)
- Competition with introduced species (e.g., for food or space)
- Disease transmission from domestic animals (including parasites)
- Vegetation composition change to less preferred or useable species
- Vegetation damage or destruction due to grazing by domestic animals

Human Disturbance

Human disturbance refers to the human disruption of or interference with fish and wildlife producing stress that may be detrimental to the affected organism. This category does not include interference with or disturbance of fish or wildlife by motorized vehicles used for recreation or development activities or by construction. Some extremely sensitive species may be adversely affected by a single encounter with a solitary human or small group of humans (e.g., hikers); however, the primary concerns regarding human disturbance involve situations where repeated disturbance occurs, either by individuals or small groups of people or by solitary events involving large numbers of people. Also included here is sensory disturbance (e.g., noise, odor) of animals that is caused by presence of dwellings (e.g., subdivisions) or settlement in remote areas.

Typical impacts:

- Harassment (e.g., active chasing, presence in sensitive wildlife habitat, noise, human scent)
- Attraction to artificial food sources (e.g., feeding carnivores)

- Increased susceptibility to predation (e.g., separation of adults from young or nest)

Log Storage and Transport

Log storage and transport refers to intermediate activities that occur after trees are harvested from the land but before logs are processed. These activities include log dumping, on-water and dry land sorting, booming, barge loading and dumping, upland and water-floatation storage, and transportation by rafting. Construction and maintenance of logging roads is included under the activity category of Grading and plowing.

Typical impacts:

- Changes in dissolved oxygen, pH, and temperature of the waters
- Changes in substrate composition
- Vegetation damage or destruction due to material overlay (e.g., logs)
- Harassment
- Changes in biological oxygen demand (e.g., woody debris)
- Changes in vegetation (e.g., reduction of stream cover)
- Increased susceptibility to human harvest
- Changes in vegetation composition (aquatic)

Netting

Netting refers to the placement of nets (e.g., drift and set gill nets, bottom trawls, purse seines) in waters for the purpose of catching fish. The effects of human harvest of fish with nets for purposes of sport, commercial, or subsistence use are not considered here. Only those aspects of netting involving discarded or lost nets or net fragments are considered here.

Typical impacts:

- Entanglement (e.g., seabirds, marine mammals)
- Barriers to movement
- Attraction to an artificial food source (e.g., to fish or birds caught in the net)

Processing Geothermal Energy

Processing geothermal energy refers to the capture and use of heat energy from sources beneath the earth's surface, usually in the form of steam or hot water. Primary uses of geothermal energy are generation of electricity, space heating, and industrial processing. This definition excludes drilling operations, which are discussed under the activity of Drilling.

Typical impacts:

- Harrassment
- Barriers to movement (e.g., pipelines)
- Changes in harvest levels (e.g., improved access and increased presence of man)
- Changes in chemical composition of surface waters
- Changes in water temperature, dissolved oxygen, and pH.

Processing Lumber, Kraft, or Pulp

Processing lumber, kraft, or pulp refers to the conversion of cut timber into lumber, pulp, paper, or paper-board products. This activity excludes the felling, transport, or storage of timber, which are defined under the activity headings of Clearing and tree harvest, and Log storage and transport, respectively.

Typical impacts:

- Harrassment
- Changes in water temperature, dissolved oxygen, and pH (e.g., due to mill effluent)
- Changes in biological oxygen demand, nutrient loading (e.g., due to mill effluent)
- Changes in aquatic substrate composition
- Changes in algae and plant composition in surface waters
- Addition of toxic chemicals to surface waters (e.g., sulfites from pulp mills)
- Inducement of impingement or entrainment of fish and fish eggs

- Changes in turbidity and suspended solids in surface waters
- Barriers to movement

Processing of Minerals

Processing of minerals refers to the storage, sorting, milling, crushing, washing, sluicing, concentrating, smelting, and refining of gravel and minerals such as coal, gold, molybdenum, lead, and zinc. The impacts from tailings and waste rock disposal are included under the activity of Solid waste disposal. The extraction of minerals is included in the activities of Grading and plowing, Dredging, and Blasting.

Typical impacts:

- Harassment (e.g., noise)
- Morbidity or mortality due to ingestion or contact with chemicals (e.g., cyanide and other processing chemicals)
- Vegetation damage/destruction due to air pollution (e.g., toxic fumes from smelters), contact with chemicals (e.g., spillage of toxic processing chemicals or byproducts) and material overlay (e.g., ore storage)
- Changes in chemical composition of water (e.g., heavy metals, toxic chemicals)

Processing of Oil/Gas

Processing of oil/gas refers to the refinement or treatment of crude oil or gas for use by industry and consumers. Included in this activity are the production of oil-and gas-derived substances such as plastics and petrochemicals. The transportation of crude and refined products to and from the processing facilities is included in the activity headings of Transport of oil/gas/water - land, ice and Transport of oil/gas/water - water.

Typical impacts:

- Harassment (e.g., noise)
- Morbidity or mortality due to ingestion of petroleum or petroleum products (e.g., oil and chemical spills, plastic particles)
- Changes in chemical composition of water

- Vegetation damage/destruction due to air pollution or contact with petroleum, petroleum products, or chemicals

Sewage Disposal

Sewage disposal refers to the means by which human wastes are collected and treated. Various methods of disposal are commonly employed. They range from an out-house system involving a ground collection pit and no additional treatment to sophisticated state-of-the-art methods that involve a network of collection lines and pump stations that deliver the wastes to treatment plants that provide tertiary treatment. See the activity heading Solid waste disposal for the definition and a listing of typical potential impacts from disposal of other forms of solid wastes (e.g., seafood-processing wastes or mine tailings).

Typical impacts:

- Changes in biological oxygen demand and nutrient loading in surface waters
- Changes in turbidity and suspended solids levels in surface waters
- Changes in dissolved oxygen levels, temperatures, and salinity in surface waters
- Addition of toxic chemicals to surface waters
- Changes in aquatic substrate composition
- Changes in flow or water level in surface waters
- Changes in vegetation composition (aquatic)

Solid Waste Disposal

Solid waste disposal refers to the disposal of unuseable or unneeded materials. Major sources of solid waste include seafood processing, drilling mud and cuttings, dredge spoils, garbage, overburden, debris, abandoned cars, and contained liquid or semisolid materials (organic or mineral). Effluent wastes that result directly from processing lumber, minerals, or oil and gas are included under the activity categories Processing of lumber/kraft/pulp, Processing of minerals, and Processing of oil/gas, respectively. Waste material used as fill material for construction projects is considered under the activity headings of Filling and pile-supported structures (aquatic and wetland habitats) and Filling (terrestrial). Impacts of discarded or lost nets are discussed under Netting.

<u>Typical impacts</u>:

- ° Attraction to artificial food source (e.g., garbage)
- ° Barriers to movement (e.g., mine tailings)
- ° Changes in biological oxygen demand (BOD), nutrient loading (e.g., seafood waste)
- ° Changes in chemical composition of water (e.g., leachates)
- ° Changes in flow or water level (e.g., accelerated runoff)
- ° Changes in substrate composition or location (e.g., mine tailings)
- ° Morbidity or mortality due to ingestion of or contact with chemicals
- ° Disease transmission from domestic animals (e.g., diseased carcasses)
- ° Entrapment in excavations (e.g., land fills)
- ° Harassment
- ° Terrain alteration or destruction
- ° Vegetation damage or destruction due to mechanical removal or material overlay

Stream Crossings - Fords

The activity of fording streams refers to the movement of vehicles, including wheeled, tracked, and skid-mounted assemblies, across a flowing watercourse at a low-water crossing. Impacts from filling (e.g., during construction of a crossing pad) are included under the activity headings of Filling and pile-supported structures (aquatic and wetland habitats), and Grading and plowing. Impacts from stream diversion (e.g., during construction of a crossing pad) are included under the activity heading of Channelizing waterways.

<u>Typical impacts</u>:

- ° Changes in sedimentation rates, turbidity, suspended solids (e.g. erosion of streambanks, or during construction of crossing pad)
- ° Changes in substrate composition (e.g., compaction from traffic)

- Changes in flow or water level (e.g., if a crossing pad is constructed)

- Changes in vegetation (e.g., primarily in riparian areas at crossing point)

Stream Crossings - Structures

Stream crossing with structures refers to the construction and operation of single or multiple span bridges or the installation of culverts in order to traverse a flowing watercourse. Placement of pipelines or cables beneath streams is included under the activity headings of Transport of oil/gas/water - Land, ice and Transport of personneleEquipment/material - land, ice.

For lists of impacts associated with structured stream crossings during construction, see the activity headings of Blasting, Grading/plowing, Channelizing waterways, Drilling, Filling and pile-supported structures (aquatic and wetland habitats), and Water regulation/withdrawal/irrigation.

Typical impacts:

- Changes in sedimentation rates, turbidity, suspended solids (e.g., erosion of banks)

- Changes in substrate composition and location (e.g., scour and erosion of streambed)

- Physical barrier to movement (e.g., debris blockage)

- Changes in flow or water level (e.g., velocity barriers, excessively shallow water, pools at downstream end of culverts)

- Shock waves (e.g., during construction phase)

- Increased susceptibility to harvest or predation

Transport of Oil/Gas/Water-Land and Ice

Transport of oil, gas, and water by land refers to the movement of these materials on, above, or buried beneath the land surface and over ice. Pipelines are a commonly used method for transport, although railroads, tanker trucks, and aqueducts (water) are also used. Also included are pumping stations, gathering lines, and other production facilities. Impacts associated with pumping water for irrigation purposes are included under the activity heading of Water regulation/withdrawal/irrigation. Impacts of transport through ice, such as by ice-breaking tankers, are included under the activity heading of Transport of oil/gas/water--water.

Typical impacts:

- Barriers to movement
- Harassment (e.g., noise from pumping or compressor stations)
- Morbidity or mortality due to ingestion or contact with petroleum or petroleum products
- Vegetation damage/destruction due to contact with petroleum or petroleum products
- Changes in chemical composition of water (e.g., oil spills)

Transport of Oil/Gas/Water - Water

Transport of oil, gas, or water by water is defined as the transport of these liquid materials across or under water by pipeline, vessel, or barge, including loading and unloading liquid cargo by piping and lightering, and through ice by ice-breaking ships.

Typical impacts:

- Morbidity or mortality due to contact with or ingestion of petroleum and petroleum products
- Harassment
- Changes in substrate composition (e.g., pipeline construction)
- Changes in chemical composition of water (e.g., oil spills, dispersants)

Transport of Personnel/Equipment/Material - Air

Transport of personnel, equipment, and material by air refers to the movement of these items by helicopter, airplane, blimps, and balloons. Helicopters and airplanes are commonly used for support of seismic exploration, oil and mineral exploration, construction, and development, and fire management. Balloons and blimps are often used for logging in sensitive areas.

Typical impacts:

- Collision with aircraft
- Harassment (e.g., hazing, noise)
- Introduction of non-native species (e.g., rats, mice, flies)

Transport of Personnel/Equipment/Material - Land and Ice

Transport of personnel, equipment, and material by land refers to automobile, truck, rail, hovercraft, snowmachine, and all-terrain vehicle transportation of people, equipment, and material. This category also includes the transmission of electrical power and telephone messages over transmission lines. This activity incorporates transportation of people and equipment even when associated with the construction or operation of systems included in other categories (e.g., pipelines). Transportation of petroleum and petroleum products by tanker trucks or by rail car is included in the activity category of Transport of oil/gas/water - land, ice. Transport of equipment or material through ice, such as by ice-breaking ships, is included under the activity heading of Transport of personnel/equipment/material--water.

Typical impacts:

- Attraction to an artificial food source (e.g., food stored in unattended vehicles)
- Barriers to movement (e.g. above-ground pipelines with insufficient clearance for passage of large mammals)
- Collision with vehicles
- Electrocution (e.g., contact with powerlines)
- Entanglement in debris (e.g., such as downed powerlines)
- Harassment (e.g., chasing, noise)
- Introduction of non-native species (e.g., rats, mice, flies)

Transport of Personnel/Equipment/Material - Water

This activity refers to transport over or through water by vessel or barge, or submarine. Pipelines and bridges are discussed under the activity headings of Stream Crossings - structures, Transport of personnel/equipment/material - land,ice, and Transport of oil/gas/water -

land and water. Transport over ice roads is discussed under Transport of personnel/equipment/material--land,ice.

Typical impacts:

- Morbidity or mortality due to contact with chemicals
- Changes in noise level
- Changes in chemical composition of water (e.g., bilge pumping, leaching of toxic materials)
- Collision with vehicles (e.g., seabirds attracted to ship lights)
- Harassment
- Interference with interspecies communication (e.g., marine mammals)
- Introduction of non-native species (e.g., rats, flies, mice)

Water Regulation/Withdrawal/Irrigation

Water regulation/withdrawal/irrigation refers to the alteration of the flow and/or the appropriation of water from a stream, lake, or subsurface aquifer by active (pumps) or passive (gravity) measures. Regulation of water is primarily associated with hydroelectric and flood control projects. Irrigation for agricultural crops or to enhance productivity of native vegetation generally withdraws water from a system by way of pumps or dams. The use of diversion ditches to redirect flow from existing stream channels for irrigation or other uses is considered under the category of Channelizing waterways. Active pumping is the method used by the majority of development practices (e.g., placer mining, powerplant cooling, dust control, municipal and industrial uses). Construction and operation of canals for the purpose of transport is covered under the activity category of Channelizing waterways, whereas the maintenance of water transportation routes is included under the activity category of Dredging.

Typical impacts:

- Aquatic substrate alteration
- Barriers to movement (e.g., large impoundments, steep-sided ditches, dams)
- Entrapment in excavations or impoundments
- Changes in flow or water level

- Changes in chemical composition of water (e.g., agricultural runoff)
- Impingement or entrainment
- Vegetation composition change to less preferred or useable species
- Changes in temperature (e.g., waste cooling water)
- Changes in sedimentation rates, turbidity, suspended solids

E. Wildlife Impacts Categories

Aquatic substrate materials, addition or removal

Aquatic vegetation, destruction or change in composition

Attraction to artificial food source

Barriers to movement, physical and behavioral

Collision with vehicles or structures or electrocution by powerlines

Entanglement in fishing nets, marine or terrestrial debris, or structures

Entrapment in impoundments or excavations

Harassment, active (e.g. intentional hazing, chasing) or passive (e.g. construction or vehicle noise, human scent)

Harvest, change in level

Introduced wild or domestic species, competition with or disease transmission from

Morbidity or mortality due to ingestion of or contact with petroleum, petroleum products, or other chemicals

Parasitism and predation, increased susceptibility to

Prey base, alteration of [Note: this category is restricted to specific impacts that have been documented to affect individual prey species not discussed in the regional volumes of the Alaska Habitat Management Guides]

Shock waves (increase in hydrostatic pressure)

Terrain alteration or destruction (e.g., raptor cliffs)

Vegetation composition, change to less preferred or useable species or successional stage

Vegetation damage/destruction due to air pollution (e.g., acid rain, SO_2) or contact with petroleum products or chemicals (e.g., herbicides)*

Vegetation damage/destruction due to fire or induced parasitism (e.g., bark bettle infestation)*

Vegetation damage/destruction due to grazing by domestic or introduced animals*

Vegetation damage/destruction due to hydraulic or thermal erosion or deposition, mechanical removal, or material overlay*

Water level or water quality fluctuations (including change in drainage patterns, long-term change in water levels)

* Discussion is limited to those plant species/associations that are important to the wildlife species in question and that are specifically mentioned in a reference to impacts on the wildlife species in question.

F. Human Use Impacts Categories

Change in available transportation options

Change in community size, demography, or economic base

Change in distribution of resources

Change in quality of a resource

Change in timing of resource availability

Disturbance of use sites

Increased competition for resources

Reduced access to use sites due to a change in legal status

Reduced access to use sites due to disturbance

G. List of Abbreviations

ADF&G	Alaska Department of Fish and Game
ADF&G-A	Alaska Department of Fish and Game - Anchorage
ADF&G-F	Alaska Department of Fish and Game - Fairbanks
ADF&G-J	Alaska Department of Fish and Game - Juneau
ADF&G-N	Alaska Department of Fish and Game - Nome
ARL	Alaska Resources Library, Anchorage
BLM	Bureau of Land Management
FSL	Forest Service Laboratory
GD	Division of Game
HD	Division of Habitat Library, Anchorage
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
SD-F	Division of Sport Fish - Fairbanks
UAF	University of Alaska - Fairbanks
USDC	United States Department of Commerce
USDI	United States Department of Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service