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SUMMARY OF EXISTING UNIT VALUE ESTIMATES FOR SELECTED SPECIES AFFECTED BY THE *EXXON VALDEZ* OIL SPILL

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SUMMARY OF EXISTING UNIT VALUE ESTIMATES FOR SELECTED SPECIES AFFECTED BY THE *EXXON VALDEZ* OIL SPILL

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LITIGATION SENSITIVE - ATTORNEY WORK PRODUCT

INTRODUCTION

This document was prepared for use in assessing the natural resource damages resulting from the *Exxon Valdez* oil spill. It summarizes existing estimates of the value of some species affected by the oil spill. These estimates are presented on a per animal basis where possible. In some cases, however, estimates of the value of an entire population of a species or a number of animals are presented.

All reported estimates are from publicly available documents. Except to convert these unit values into 1989 dollars and round to the nearest dollar, no adjustments have been made to these estimates. Because this document was designed as a reference tool, we do not critique the estimates presented. In addition, we have not attempted to replicate these values.

This document is made up of three exhibits and two appendices. Exhibit 1 reports unit values by species. For each value we summarize the research method used to obtain the estimate and the source of the estimate. Exhibit 2 provides a full citation for each referenced document. Exhibit 3 provides brief descriptions of each of the species listed in Exhibit 1.

Appendix A provides extended summaries of each of the studies referenced in Exhibit 1. Appendix B provides the GNP deflators used to convert reported values to 1989 dollars.

Exhibit 1

UNIT VALUE ESTIMATES

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Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Bald Eagle	State Wildlife Restitution Values (single bird)		
	o State of Illinois, origin of value unknown.	$253	Illinois Department of Conservation (1982), as reported in O'Brien and Talhelm (1990).
	o State of Minnesota, proposed value. Based on values reported in Talhelm (1990), adjusted to reflect the professional judgment of the Minnesota Department of Natural Resources and public comment. Talhelm's results represent a composite of values reported in publicly available studies.	$4,000	Minnesota Department of Natural Resources, Division of Fish and Wildlife, Division of Enforcement (1990).
	o State of North Dakota. Value reported represents a "base" value, which is subsequently adjusted by factors related to the animal's age, size, and condition. Origin of value unknown.	$1,173	North Dakota Game and Fish Department (1984), as reported in O'Brien and Talhelm (1990).
	o State of Texas. Value is based on eight criteria reflecting wildlife's social and economic value.	$3,164	Texas Parks and Wildlife Department (1986), as reported in O'Brien and Talhelm (1990).
	o State of Virginia, proposed replacement value. Origin of value unknown.	$6,315	Halter and Thomas (1982).
	Recommended wildlife restitution values (single bird) for the State of Minnesota, derived from a composite of willingness-to-pay, willingness-to-accept, and travel cost based studies reported in publicly available literature. The unit value combines estimates for hunting, viewing, option, existence, market, ecological, and nuisance value.	$20,000	Talhelm (1990).
	Economic Values (not expressed per bird)		
	o A contingent valuation survey that assessed willingness-to-pay for membership in a foundation responsible for the preservation of Wisconsin's bald eagle population.	$81	Boyle and Bishop (1987).
	o A contingent valuation survey that assessed use values for Maine's wildlife resources. Estimated the value of an increase in the number of nesting bald eagle pairs in Maine from 109 to 200. The reported value indicates the mean annual willingness-to-pay per household to achieve this increase.	$14	Boyle et al. (1990).

Exhibit 1 UNIT VALUE ESTIMATES			
Species	**Basis of Estimate**	**Unit Value (1989)**	**Source**
Bald Eagle (continued)	Market Value for Illegally Traded Wildlife		
	o Value of a single bird, from The Arizona Republic, April 1989.	$400	U.S. Fish and Wildlife Service, Division of Law Enforcement (1990).
	o Value of bald eagle feathers, from Los Angeles Times, 1981.	$3,359	U.S. Fish and Wildlife Service, Division of Law Enforcement (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Eagle, general	State Wildlife Restitution Values (single bird)		
	o State of Arizona, minimum value. Origin of value unknown.	$854	Arizona Game and Fish Department (1985), as reported in O'Brien and Talhelm (1990).
	o State of Colorado, based on such factors as the relative abundance of the species, license costs, and perceived value to people viewing wildlife. The Colorado Department of Natural Resources, Division of Wildlife plans to raise the value to $2,500 in 1991.	$1,139	Colorado Department of Natural Resources, Division of Wildlife (1985), as reported in O'Brien and Talhelm (1990).
	o State of Illinois. Origin of value unknown.	$158	Illinois Department of Conservation (1982), as reported in O'Brien and Talhelm (1990).
	o State of Kansas, minimum value. Origin of value unknown.	$500	Kansas Wildlife and Parks, as reported in O'Brien and Talhelm (1990).
	o State of Michigan, as stated in the "Wild Life Conservation Act", Act 256, Public Acts of 1988.	$1,500	Michigan Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).
	o State of Nevada. Origin of value unknown.	$250	Nevada Department of Wildlife (1989), as reported in O'Brien and Talhelm (1990).
	o State of Ohio. Origin of value unknown.	$1,076	Ohio Department of Natural Resources (1987), as reported in O'Brien and Talhelm (1990).
	o State of West Virginia. Origin of value unknown.	$632	West Virginia Department of Natural Resources (1982), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Pigeon Guillemot	Economic Values (single bird)		
	o Estimated use value, reflecting total willingness-to-pay by California residents for wildlife viewing, allocated equally among all California species. Single bird values estimated as the individual species value divided by a population size factor.	$171	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	o Estimated existence value, reflecting the total existence value of all California birds allocated equally among species. Single bird values estimated as the individual species value divided by a population size factor.	$433	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	Purchase Cost (single bird), values from zoos and aquariums.	$114, $260, $285(2), $569, $911	Sterling Hobe Corporation (1985), as reported in James Dobbin Associates, Inc. (1986).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Common Murre	Economic Values (single bird)		
	o Estimated use value, reflecting total willingness-to-pay by California residents for wildlife viewing, allocated equally among all California species. Single bird values estimated as the individual species value divided by a population size factor.	$56	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	o Estimated existence value, reflecting the total existence value of all California birds allocated equally among species. Single bird values estimated as the individual species value divided by a population size factor.	$87	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	Purchase Cost (single bird), value from zoos and aquariums.	$114, $228, $260, $285 $569, $911	Sterling Hobe Corporation (1985), as reported in James Dobbin Associates, Inc. (1986).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Marbled Murrelet	Economic Values (single bird)		
	o Estimated use value, reflecting total willingness-to-pay by California residents for wildlife viewing, allocated equally among all California species. Single bird values estimated as the individual species value divided by a population size factor.	$1,712	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	o Estimated existence value, reflecting the total existence value of all California birds allocated equally among species. Single bird values estimated as the individual species value divided by a population size factor.	$4,537	Walgenbach (1979), as reported in James Dobbin Associates, Inc. (1986).
	Purchase Cost (single bird), values from zoos and aquariums.	$114, $260, $285(2), $569, $911	Sterling Hobe Corporation (1985), as reported in James Dobbin Associates, Inc. (1986).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Duck, general	State Wildlife Restitution Values (single bird)		
	o State of Arizona, minimum value. Origin of value unknown.	$17	Arizona Game and Fish Department (1985), as reported in O'Brien and Talhelm (1990).
	o State of Louisiana, based on actual replacement cost to the Department of Wildlife and Fisheries, National Hunting and Fishing Surveys, and state and national small game hunting expenditures.	$11	Louisiana Department of Wildlife and Fisheries (1990), as reported in O'Brien and Talhelm (1990).
	o State of Maryland, adapted from Michigan Department of Natural Resources value.	$100	Maryland Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).
	o State of Minnesota, proposed value. Based on values reported in Talhelm, 1990, adjusted to reflect the professional judgment of the Minnesota Department of Natural Resources and public comment. Talhelm's results represent a composite of values reported in publicly available studies.	$50	Minnesota Department of Natural Resources. Division of Fish and Wildlife, Division of Enforcement (1990).
	o State of North Carolina, replacement costs. Value based on ten factors, including the species' statewide population, cost of purchasing suitable habitat, habitat requirements, costs of raising an individual of the species in captivity, and survival rates of individuals raised in captivity and released in the wild.	$19	North Carolina Administrative Code, Wildlife Resources and Water Safety (1989).
	o State of North Dakota. Value reported represents a "base" which is subsequently adjusted by factors related to the animal's age, size, and condition. Origin of value unknown.	$29	North Dakota Game and Fish (1984), as reported in O'Brien and Talhelm (1990).
	o State of New Hampshire. Origin of value unknown.	$38	New Hampshire Fish and Game Department (1973), as reported in O'Brien and Talhelm (1990).
	o State of Virginia. Origin of value unknown.	$26	Virginia Department of Game and Inland Fisheries (1988), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Duck, general (continued)	o State of West Virginia. Origin of value unknown.	$13	West Virginia Department of Natural Resources (1982), as reported in O'Brien and Talhelm (1990).
	o State of Wyoming, determined by dividing hunters' expenditures by the number of animals harvested.	$33	Wyoming Game and Fish Department (1989), as reported in O'Brien and Talhelm (1990).
	Recommended wildlife restitution values (single bird) for the State of Minnesota, derived from a composite of willingness-to-pay, willingness-to-accept, and travel cost based studies reported in publicly available literature. The reported unit value combines estimates for hunting, viewing, option, existence, market, ecological, and nuisance value.	$40	Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Migratory Birds, general	Economic Values (single bird)		
	o Incremental value for migratory bird hunting estimated based on an expenditure equation approach using data from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation.		
	- Incremental bag value (opportunity cost of time set equal to zero).	$13	Charbonneau and Hay (1978).
	- Incremental per bag value (including the opportunity cost of time).	$17	Charbonneau and Hay (1978).
	Economic Values (not expressed per bird)		
	o Estimated willingness-to-pay per recreation day, based on analysis of the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation.	$82	Brown (1978), as reported in Walgenbach (1979).
	o Incremental value for migratory bird hunting estimated based on an expenditure equation approach using data from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation.		Charbonneau and Hay (1978).
	- Incremental user day value (opportunity cost of time set equal to zero).	$6	
	- Incremental user day value (including the opportunity cost of time).	$30	

Exhibit 1 UNIT VALUE ESTIMATES			
Species	**Basis of Estimate**	**Unit Value (1989)**	**Source**
Migratory Birds, general (continued)	Economic Values (not expressed per bird)		
	o Contingent valuation survey using willingness-to-pay responses to assess average per day consumer surplus associated with hunting wildlife (using data from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation). Standard error of value is $34 for a sample size of 41 responses. The authors' model controls for seasons of hunting experience, household income, willingness-to-pay for a second favorite hunting activity, and seasonal and daily harvest rates.	$83	Charbonneau and Hay (1978).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Waterfowl, general	State Wildlife Restitution Values (single bird)		
	o State of Massachusetts. Origin of value unknown.	$25	Massachusetts Department of Fish and Wildlife and Environmental Law Enforcement (1989), as reported in O'Brien and Talhelm (1990).
	Economic Values (single bird)		
	o The value of bagging an additional bird, calculated from a contingent valuation survey of households in Saskatchewan Province, Canada. The authors' model controlled for household income, seasons of experience and missed shots.	$3 (Canadian)	Cocheba and Langford (1978).
	o The marginal value of an additional bird in the fall flight, calculated from a contingent valuation survey of households in Saskatchewan Province, Canada. Following the authors' calculation, the value is 1/300 of the marginal value of an increase of 300 birds.	$2 (Canadian)	Cocheba and Langford (1978).
	o Estimate (low/high) of the marginal value for waterfowl, using an optimal control model. The model attempts to determine the optional level of breeder ducks, ponds, and harvest using data on mallard hunting in the Pacific flyway, as an alternative to the maximum sustained yield approach. The range of values result from a range of assumptions for the cost of ponds.	$5/$10	Brown and Hammack (1972), as reported in Krutilla and Fisher (1975).
	o Estimate of the use value of waterfowl applying contingent valuation methodology and the results of Hammack and Brown (1974) to Atlantic Flyway conditions in Virginia.	$8/$17	Brown and Hammack (1977).
	o Estimate of existence value for waterfowl based on actual costs to successfully treat birds damaged by oil.	$33	Brown and Hammack (1977).
	o Estimate (low/high) of the marginal value for waterfowl, using a contingent valuation survey that elicited willingness-to-pay and willingness-to-sell values for waterfowl hunting permits.	$30	Hammack and Brown (1974).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Waterfowl, general (continued)	Economic Values (single bird)		
	o Incremental per bag value, estimated from a contingent valuation survey using willingness-to-pay responses to assess consumer surplus for waterfowl hunting. The authors' model controls for seasons of hunting experience, household income, willingness-to-pay for a second favorite hunting activity, and seasonal and daily harvest rates.	$9	Charbonneau and Hay (1978).
	o Incremental value for waterfowl hunting estimated based on an expenditure equation approach using data from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation.		Charbonneau and Hay (1978).
	- Incremental bag value (opportunity cost of time set equal to zero).	$26	
	- Incremental per bag value (including the opportunity cost of time).	$53	
	o A composite of willingness-to-pay values, per bird, based on contingent valuation studies of values per hunter day.	$18	Talhelm (1990).
	o A composite of consumer surplus values, per bird, based on values per hunter day generated from travel cost and hedonic models.	$10	Talhelm (1990).
	o A composite of willingness-to-accept values, per bird, based on a transformation of willingness-to-pay and consumer surplus values per hunter day.	$27	Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Waterfowl, general (continued)	Economic Values (single bird)		
	o A composite of willingness-to-pay values, per bird, based on contingent valuation and hedonic method studies of value per bagged animal.	$3	Talhelm (1990).
	o A composite of consumer surplus values, per bird, based on value per bagged animal generated using exploitation rates and hedonic models.	$12	Talhelm (1990).
	o A composite of willingness-to-accept values, per bird, based on a transformation of willingness-to-pay and consumer surplus values per bagged animal.	$12	Talhelm (1990).
	Economic Values (not expressed per bird)		
	o The marginal value of taking an unsuccessful shot, calculated from a contingent valuation survey of households in Saskatchewan Province, Canada.	$0.50 (Canadian)	Cocheba and Langford (1978).
	o A contingent valuation survey using willingness-to-pay responses to assess consumer surplus for waterfowl hunting. The authors' model controls for seasons of hunting experience, household income, willingness-to-pay for a second favorite hunting activity, and seasonal and daily harvest rates.		Charbonneau and Hay (1978).
	- Average per day consumer surplus. Standard error of value is $4 for a sample size of 549 responses.	$70	
	- Incremental per day value.	$15	
	o Estimate of average annual values (consumptive and nonconsumptive) for waterfowl hunting from multiple surveys of Maine residents.	$551	Boyle et al. (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Waterfowl, general (continued)	Economic Values (not expressed per bird)		
	o Estimated willingness-to-pay per waterfowl hunter day, from a survey of hunting, fishing and associated recreation.	$70	Brown (1978), as reported in Walgenbach (1979).
	o Composite of net economic user day value for waterfowl hunting reported by travel cost and contingent valuation demand studies from 1968 to 1988 applied to National Forest recreation use categories.	$38	Walsh et al. (1989).
	o Incremental value for waterfowl hunting estimated based on an expenditure equation approach using data from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation.		Charbonneau and Hay (1978).
	- Incremental user day value (opportunity cost of time set equal to zero).	$19	
	- Incremental user day value (including the opportunity cost of time).	$62	

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Sea Otter	Economic Value (single animal)		
	o Per animal value, derived from costs incurred in Exxon-sponsored otter rehabilitation program, in response to the *Exxon Valdez* oil spill.		Williams and Davis (1990).
	- Per animal value based on total number of otters treated (357), and estimated total cost ($18.3 million).	$51,261	
	- Per animal value based on number of otters actually rehabilitated and released (225) and estimated total cost.	$81,333	
	o Value (low/high) for the sale of one otter.	$8,000/$12,000	Communication with curator of Marine Mammals at Vancouver Aquarium (1991).
	Economic Values (not expressed per animal)		
	o A contingent valuation survey which estimated mean annual willingness-to-pay per California household to avoid a reduction of the California sea otter population from 1,500 to 100 individuals.	$24	Hageman (1985).
	Market Value for Illegally Traded Wildlife		
	o Value of a single pelt.	$1,500	U.S. Fish and Wildlife Service, Division of Law Enforcement (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Otter, general River	State Wildlife Restitution Values (single bird)		
	o Alberta, Canada "Collective Assessment" value based on relative market value as live animals. Applies to wildlife lawfully collected or granted for private possession in captivity.	$81 (Canadian)	Albert Forestry, Lands and Wildlife (1987), as reported in O'Brien and Talhelm (1990).
	o State of Massachusetts. Origin of value unknown.	$200	Massachusetts Department of Fish and Wildlife, and Environmental Law Enforcement (1989), as reported in O'Brien and Talhelm (1990).
	o State of Maryland, adapted from Michigan Department of Natural Resources value.	$100	Maryland Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).
	o State of North Carolina, replacement cost. Value based on ten factors, including the species' statewide population, cost of purchasing suitable habitat, habitat requirements, costs of raising an individual of the species in captivity, and survival rates of individuals raised in captivity and released in the wild.	$300	North Carolina Administrative Code, Wildlife Resources and Water Safety (1989).
	o State of New Hampshire. Origin of value unknown.	$510	New Hampshire Fish and Game Department (1973), as reported in O'Brien and Talhelm (1990).
	o State of Texas, based on eight criteria reflecting wildlife's social and economic value.	$70	Texas Parks and Wildlife Department (1986), as reported in O'Brien and Talhelm (1990).
	o State of Virginia. Origin of value unknown.	$156	Virginia Department of Game and Inland Fisheries (1988), as reported in O'Brien and Talhelm (1990).
	o State of Wisconsin. Origin of value unknown.	$100	Wisconsin Department of Natural Resources (1985), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Otter, general (continued)	o State of West Virginia. Origin of value unknown.	$32	West Virginia Department of Natural Resources (1982), as reported in O'Brien and Talhelm (1990).
	o State of Minnesota, proposed value. Based on values reported in Talhelm (1990), adjusted to reflect the professional judgment of the Minnesota Department of Natural Resources and public comment. Talhelm's results represent a composite of values reported in publicly available studies.	$100	Minnesota Department of Natural Resources, Division of Fish and Wildlife, Division of Enforcement (1990).
	Recommended wildlife restitution values (single animal) for the State of Minnesota, derived from a composite of willingness-to-pay, willingness-to-accept, and travel cost based studies reported in publicly available literature. The unit value combines estimates for hunting, viewing, option, existence, market, ecological, and nuisance value.	$60 + fur or pelt market value	Talhelm (1990).

Exhibit 1 UNIT VALUE ESTIMATES			
Species	**Basis of Estimate**	**Unit Value (1989)**	**Source**
Harbor Seal	Economic Values (not expressed per animal) o A contingent valuation survey that estimated the economic loss, per California household, of a decline in the local seal population by 10 percent (30 seals). Results were reported as mean willingness-to-pay per household. The range reflects variation in the mean among the four counties surveyed.	$120-$402	Meyer (1987).

Exhibit 1 UNIT VALUE ESTIMATES			
Species	**Basis of Estimate**	**Unit Value (1989)**	**Source**
Marine Mammal, general	Replacement Value or Purchase Cost o Non-game species values determined using data from pet shops and zoos.	$2,000	Louisiana Department of Wildlife and Fisheries (1990), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Endangered Species	State Wildlife Restitution Values (single bird or animal)		
	o Proposed unit restitution values for endangered species. Based on values reported in Talhelm (1990), adjusted to reflect the professional judgment of the Minnesota Department of Natural Resources, cost of reintroduction programs, and public comment. Talhelm's results represent a composite of values reported in publicly available studies.		Minnesota Department of Natural Resources, Division of Fish and Wildlife, Division of Enforcement (1990).
	- Endangered mammal or bird	$4,000	
	- Other endangered species	$2,000	
	o Suggested unit restitution value for endangered species. Recommended wildlife restitution values (single bird or animal) for the State of Minnesota, derived from a composite of willingness-to-pay, willingness-to-accept, and travel cost based studies reported in publicly available literature. The unit value combines estimates for hunting, viewing, option, existence, market, ecological, and nuisance value.		Talhelm (1990).
	- Endangered mammal or bird	$90,000	
	- Other endangered species	$10,000	
	o State of Arizona, minimum value. Origin of value unknown.	$854	Arizona Game and Fish (1985), as reported in O'Brien and Talhelm (1990).
	o State of Colorado, based on such factors as the relative abundance of the species, license costs and perceived value to people viewing wildlife.	$1,139	Colorado Department of Natural Resources, Division of Wildlife (1985), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Endangered Species (continued)	State Wildlife Restitution Values (single bird or animal)		
	o State of Massachusetts. Origin of value unknown.	$2,000	Massachusetts Department of Fish and Wildlife, Division of Environmental Law Enforcement (1989), as reported in O'Brien and Talhelm (1990).
	o State of Maryland, adapted from Michigan Department of Natural Resources value.	$1,250	Maryland Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).
	o State of Michigan, obtained from the "Wild Life Conservation Act" Act 256, Public Acts of 1988.	$1,500	Michigan Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).
	o State of Montana. Origin of value unknown.	$1,000	Montana Department of Fish, Wildlife and Parks (1989), as reported in O'Brien and Talhelm (1990).
	o State of Washington. Origin of value unknown.	$2,152	Washington Department of Wildlife (1987), as reported in O'Brien and Talhelm (1990).
	o State of Wisconsin. Origin of value unknown.	$997	Wisconsin Department of Natural Resources (1985), as reported in O'Brien and Talhelm (1990).
	o State of North Carolina, replacement costs. Value based on ten factors, including the species' statewide population, cost of purchasing suitable habitat, habitat requirements, costs of raising an individual of the species in captivity, and survival rates of individuals raised in captivity and released in the wild.	$2,300	North Carolina Administrative Code, Wildlife Resources and Water Safety (1989).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Threatened Species	State Wildlife Restitution Values (single bird or animal)		
	o Proposed unit restitution values for threatened species. Based on values reported in Talhelm, 1990, adjusted to reflect the professional judgment of the Minnesota Department of Natural Resources and public comment. Talhelm's results represent a composite of values reported in publicly available studies.		Minnesota Department of Natural Resources, Division of Fish and Wildlife, Division of Enforcement (1990).
	- Threatened mammal or bird	$2,000	
	- Other threatened species	$500	
	o Suggested unit restitution value for threatened species. Derived from a composite of willingness-to-pay, willingness-to-accept, and travel cost based studies reported in publicly available literature. The unit value combines estimates for hunting, viewing, option, existence, market, ecological, and nuisance value.		Talhelm (1990).
	- Threatened mammal or bird	$5,000	
	- Other threatened species	$500	
	o State of North Carolina, replacement costs based on American Fisheries Society and Wildlife Resources Commission suggested values.	$2,000	North Carolina Administrative Code, Wildlife Resources and Water Safety (1989).
	o State of Maryland, adapted from Michigan Department of Natural Resources values.	$750	Maryland Department of Natural Resources (1989), as reported in O'Brien and Talhelm (1990).

Exhibit 1

UNIT VALUE ESTIMATES

Species	Basis of Estimate	Unit Value (1989)	Source
Threatened Species (continued)	o State of Massachusetts. Origin of value unknown.	$1,000	Massachusetts Department of Fish and Wildlife, Division of Environmental Law Enforcement (1989), as reported in O'Brien and Talhelm (1990).
	o State of Colorado, based on such factors as the relative abundance of the species, license costs and perceived value to people viewing wildlife.	$797	Colorado Department of Natural Resources, Division of Wildlife (1985), as reported in O'Brien and Talhelm (1990).
	o State of Kansas, minimum value. Origin of value unknown. Value is for endangered/threatened species class. Basis year not reported.	$200	Kansas Wildlife and Parks, as reported in O'Brien and Talhelm (1990).
	o State of Ohio. Origin of value unknown. Value is for endangered/threatened species class.	$807	Ohio Department of Natural Resources (1987), as reported in O'Brien and Talhelm (1990).
	o State of Oregon. Origin of value unknown. Value is for endangered/threatened species class.	$672	Oregon Department of Fish and Wildlife (1981), as reported in O'Brien and Talhelm (1990).

Exhibit 2

BIBLIOGRAPHY
SELECTED WILDLIFE VALUATION LITERATURE

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Exhibit 2

BIBLIOGRAPHY

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State of Minnesota, Department of Natural Resources, Divisions of Fish and Wildlife and Enforcement, In the Matter of the Proposed Adoption of Rules Prescribing Restitution Values for Fish and Wildlife Illegally Killed, Injured, or Possessed: Statement of Need and Reasonableness, State of Minnesota, Department of Natural Resources, 1991.

Talhelm, Daniel R., "Recommended Values for Computing Fair Restitution to the Citizens of Minnesota for Fish and Wildlife Illegally Killed, Injured, or Possessed," prepared for Minnesota Department of Natural Resources, 1990.

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Exhibit 3

SPECIES DESCRIPTIONS

Exhibit 3

SPECIES DESCRIPTIONS

Otter, sea *(Enhydra lutris)*

Sea otter populations are scattered throughout the North Pacific from the southwestern area of the Kuril Islands up to the Aleutians and into the northeastern Gulf of Alaska. There are also smaller populations located in the Alexander Archipelago of the eastern Gulf, as well as in the area of Monterey, California. Within Prince William Sound, the most well established sea otter habitat is on Green Island. Although most of the North Pacific population is not protected by federal statutes, the California population has a threatened status as set forth by the U.S. Fish and Wildlife Service. Population estimates from studies done in the 1970's indicate a total population of between 100,000 and 150,000 individuals, with the California population presently estimated at 1,800 to 2,000 individuals.

Reproduction for the sea otter populations of Alaska and California tends to be seasonal. Specifically, mating in Prince William Sound takes place in the fall, with pupping in May. It is likely that this pattern is exhibited by sea otters elsewhere in the Gulf, although the mating season might be extended into December, and the pupping season into the summer months.

Primarily a coastal species, most sea otters remain within a small area on a day to day basis, although it is not unusual for the Alaska and California populations to move longer distances over a few days. Most movements are dictated by the availability of both feeding areas and specific kelp beds. Kelp is the preferred resting spot; otters use kelp as protection from drifting while resting and from predators. In Alaska sea otters are known to rest on ice or land since there is little kelp available. Resting is often done in large groups.

Sources:

Geraci, J.R. and St. Aubin, D.J. (1990). Sea Mammals and Oil, Confronting the Risks. Academic Press, Inc. San Diego, California.

"The 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill." August, 1990.

U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants." 50 CFR 17.11 and 17.12. April 15, 1990.

Exhibit 3

SPECIES DESCRIPTIONS
(continued)

Seal, harbor *(Phoca vitulina)*

Harbor seals are widely distributed throughout North American coastal and shelf waters, from coastal areas of Mexico in the Pacific, to the Arctic ocean, through Canadian waters as far south as New England. One of the most commonly occurring marine mammal populations in Prince William Sound, the harbor seal population in Southern Alaska was estimated at a stable 67,000 in 1980 and 1983 studies, comprising at least 47 percent of the estimated worldwide population of harbor seals.

Harbor seals are considered to be a solitary species, commonly referred to as non-gregarious. It is not uncommon, however, for these animals to form noninteractive groups, especially when the focal point is a feeding or haulout resource.

Like all pinnipeds, the migration pattern of harbor seals is inshore-offshore as opposed to the north-south movement of other marine mammals. They are predominantly found in coastal waters but use the shore to breed and molt, and for other occasions to haulout. The harbor seal population of the Gulf of Alaska and Prince William Sound is year-round. Haulout sites in this area are used for all purposes (birthing, molting and resting) as opposed to other pinnipeds with well-established breeding colony sites used exclusively for reproductive activities. Populations of northern British Columbia and Alaska give birth in May or June, mate in the mid summer months of June and July, and molt in July, August and September.

Sources:

Geraci, J.R. and St. Aubin, D.J. (1990). Sea Mammals and Oil, Confronting the Risks. Academic Press, Inc. San Diego, California.

"The 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill." August, 1990.

Exhibit 3

SPECIES DESCRIPTIONS
(continued)

Eagle, bald *(Haliaeetus leucocephalus)*

The bald eagle was once known to breed throughout North America. Today, the only known breeding grounds are in Alaska, parts of northern and eastern Canada, parts of the conterminous northern United States and Florida. The population of the conterminous United States is considered as endangered by the U.S. Fish and Wildlife Service, except for Washington, Oregon, Minnesota, Wisconsin, and Michigan, where bald eagles are federally protected as a threatened species. There are roughly 5,000 bald eagles in the Gulf area.

Lakes, marshes, rivers, and seacoasts are the habitat of the bald eagle with their nests most commonly found at the top of a tall tree, and sometimes on top of a cliff. All members of the *Accipitridae* family mainly feed on meat, such as mammal, bird, or reptile, with smaller birds eating insects as well. Around coastal areas it is quite common to see bald eagles feeding on dead fish washed ashore. In winter these birds might be seen along any shoreline of water, especially larger rivers and bodies of water in the interior regions of the continent. Resident populations are believed to exist in Washington, on the Pacific coast of Canada and Florida.

Sources:

Bull, J. and Farrand, J., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Eastern Region. Chanticleer Press, Inc., New York, New York.

Fry, Dr. M. University of California. Davis, California. Personal communication (11-1-90).

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U.S. Fish and Wildlife Service. "Endangered and Threatened Wildlife and Plants." 50 CFR 17.11 and 17.12. April 15, 1990.

Guillemots, pigeon *(Cepphus columba)*

Similar to other members of the family *Alcidae*, the pigeon guillemot is indigenous to colder coastal areas. The pigeon guillemot range is the Pacific coast, from the Aleutians and islands of the Gulf of Alaska to southern California. There are an estimated 10,000 individuals in the greater Prince William Sound and northwestern Gulf region.

Pigeon guillemots primarily winter far offshore. It is possible, however, to find these birds at inshore locations during this season, particularly in the Aleutians. Breeding occurs in the Aleutians and islands of the Gulf and along the Pacific coast, from Canada to Southern California. Feeding grounds are mainly shallow inshore waters of rocky coastal areas which allow them to dive for small fish, their preferred food source. These birds usually nest on coastal cliffs in small burrows or crevices.

Sources:

Bull, J. and Farrand, J., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Eastern Region. Chanticleer Press, Inc., New York, New York.

Piatt, J., et al. (1990). "Immediate Impact of the 'Exxon Valdez' Oil Spill on Marine Birds." Auk, Volume 107. April, 1990.

Udvardy, M., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Western Region. Chanticleer Press, Inc., New York, New York.

United States Fish and Wildlife Service. Datalog of Alaskan Seabird Colonies.

SPECIES DESCRIPTIONS
(continued)

Murre, common *(Uria aalgae)*
Murre, thick-billed *(Uria lomvia)*

The population of murres in Prince William Sound and the northwestern Gulf of Alaska is estimated to be 350,000 individuals, the majority of which are common murres. It is likely that murres are the most frequently occurring birds in the north Gulf coast - Prince William Sound area.

Like other members of the *Alcidae* family (21 species total), murres use the rocky coast as a place to breed and lay eggs amidst bare cliffs, crevices, burrows, and ledges. During the winter months they feed in the open sea by diving for small fish and squid, returning to land only for nesting. These birds' eggs are known to be a food source for native subsistence peoples.

Murres occur in arctic and subarctic shore areas. In the Pacific, common murres breed along the California coast, the western Aleutians and the western Gulf; and in the Atlantic, along the islands of the Gulf of St. Lawrence. Thick-billed murres breed in the Gulf, on shore areas from the Aleutians to the Pacific coast of Canada, as well as in some areas of the Bering Sea, northern Canada, Greenland, Iceland and northern Eurasia. Common murres winter all along the Pacific coast from the Gulf to southern California, and both species are found during winter in the Atlantic as far south as Massachusetts. There are resident murre populations in the western Gulf and on the islands of the Gulf of St. Lawrence.

Sources:

Bull, J. and Farrand, J., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Eastern Region. Chanticleer Press, Inc., New York, New York.

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Udvardy, M., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Western Region. Chanticleer Press, Inc., New York, New York.

Murrelet, ancient *(Synthliboramphus antiquus)*
Murrelet, Kittlitz' *(Brachyramphus brevirostris)*
Murrelet, marbled *(Brachyramphus marmoratus)*

The Kittlitz's murrelet, the marbled murrelet and the ancient murrelet are North Pacific birds of the *Alcidae* family. Approximately 50,000 individuals occur in the greater Prince William Sound and Gulf of Alaska coastal areas. The marbled murrelet's range is comprised of resident populations from Kodiak Island of Alaska south to central California. Ancient murrelets occur in and around offshore islands of the North Pacific and Bering Sea and as far south as central British Columbia, although some winter as far as southern California. There are scattered resident populations throughout this range as far south as Washington. The Kittlitz's murrelet, one of the least known of North American birds, is found only along the coasts of the Bering Sea, Aleutians and southeastern Alaska.

Murrelets breed in colonies in coastal areas and feed by diving for small fish and other aquatic animals. The Kittlitz's murrelet nests on rock and debris slopes of high mountains and frequents ocean waters and glacier bays. Marbled murrelets breed in coastal rain forests and frequent inshore waters at other times. Ancient murrelets nest by burrowing and remain near the open ocean. The nesting habits of the marbled murrelet have only recently been discovered and it is believed that they nest differently than most other alcids by locating their nests high in trees, sometimes several miles from shore.

Sources:

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Udvardy, M., The American Museum of Natural History (1977). The Audubon Society Field Guide to North American Birds, Western Region. Chanticleer Press, Inc., New York, New York.

Sea Ducks (family *Anatidae*)

Worldwide, there are 150 species of sea ducks (*Anatidae* family) with forty-three of these species breeding in North America. Of these at least seven are known to occur in the greater Prince William Sound area, totalling an estimated 60,000 to 100,000 individuals. These include: Old Squaw *(Clangula hyemalis)*, black, or "common", scoter *(melanitta nigra)*, eider *(somateria mollissima, S. spectabilis)*, Harlequin duck *(Histrionicus histrionicus)*, Barrow's goldeneye *(Bucephala islandica)*, common goldeneye *(Bucephala clangula)* and surf scoter *(Melanitta perspicillata)*.

Sea ducks feed in coastal areas on wetland plants and seeds, small aquatic animals such as snails and chitons, fish, crabs and mussels. For this reason, most nest on or near bays, estuaries, or on shallow inshore waters and banks. During the breeding season the preferred habitat ranges from tundra ponds and marshland for the Old Squaw, forested lake areas selected by the Barrow's goldeneye, to the use of holes in trees by the common goldeneye.

Most sea ducks are migratory, breeding in arctic coastal regions of Pacific North America, arctic Siberia, Canada, Alaska and northern Bering Sea. Some, such as the Harlequin duck, breed as far south as Wyoming, but this is not common. In the winter, the majority of these birds move south to the Aleutians, sites in the Gulf of Alaska, and along the coast of California. Some, such as the common goldeneye, winter as far south as the Gulf of Mexico. There are some resident sea duck populations such as the Harlequin ducks of Prince William Sound. Many sea duck species occur on both coasts of the United States during winter months.

Sources:

Piatt, J. and Lensink, C. "Highest Toll of Marine Birds from Oil Pollution - the 'Exxon Valdez' Oil Spill." Alaska Fish and Wildlife Research Center. Anchorage, Alaska.

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Trout *(Salmonidae)*

Dolly Varden *(Slavelinus malma)* and cutthroat *(Salmo clarkii)* trout are small freshwater fish which are closely related to salmon species. They are not only actively pursued by sport fishermen but also serve as an important subsistence food source and are harvested commercially in many regions.

These fish are considered freshwater species because they spawn in fresh water. It is not unusual, however, for trout to migrate to the sea during portions of their life cycles. Spawning usually takes place in gravel-bottomed streams and riverbeds, with eggs hatching approximately four to seven weeks later. Most trout make use of nearshore, estuarine-like habitats feeding on insects, small crustaceans, worms, smaller fish and their eggs.

The cutthroat trout is abundant throughout the Pacific coast of the United States from Alaska down to Mexico. It has an average weight of seven pounds, but has been known to reach 41 pounds. The spawning season for cutthroat trout varies with its range: higher latitude populations lay their eggs in summer, lower latitude populations in spring. The size of the Dolly Varden varies with its environment, with an average weight of 15 pounds in the sea to a mere half pound in small streams. The Dolly Varden spawns in the fall and winter.

Sources:

Filisky, M. (1989). Peterson First Guides to Fishes of North America. Houghton Mifflin Company. Boston, Massachusetts.

The Encyclopedia Americana, International Edition. Grolier Incorporated (1989). Danbury, Connecticut.

"The 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill." August, 1990.

Appendix A

SUMMARIES OF SELECTED WILDLIFE VALUATION LITERATURE

Boyle, Kevin J. and Richard C. Bishop. "Valuing Wildlife in Benefit-Cost Analyses: A Case Study Involving Endangered Species," Water Resources Research, 23(5):943-950. May 1987.

Data Source(s)

Survey of 1,000 Wisconsin taxpayers by the Wisconsin Department of Natural Resources. The survey was mailed to 500 taxpayers who had contributed to a state wildlife fund and 500 who had not. The survey included several questions designed by the authors to elicit willingness-to-pay to save bald eagles. The survey had an 81 percent overall response rate (somewhat higher for contributors and lower for non-contributors).

Methodology

Boyle and Bishop used the contingent valuation method to estimate total non-consumptive use value (viewing and existence value) and existence value alone for bald eagles. Existence value was also estimated for striped shiners. The authors used a dichotomous choice technique that involved acceptance or rejection of membership, for a fixed fee, in a foundation expected to ensure preservation of the species. The membership fee specified in each survey was a randomly selected, whole dollar value between $1 and $100. Respondents were classified as bald eagle viewers or nonviewers based on their response to the following question: Have you ever made a trip where one of your intentions was to view bald eagles?

Survey results were analyzed with a logit model of the following form:

$$\Pr(\text{YES}) = [1 + \exp(-BX)]^{-1}$$

"B" represents a vector of parameters, and "X" represents a vector of variables that includes the membership fee specified in the individual survey. No income control variable was possible, and other descriptive variables were found to have no explanatory variable. Thus, specification of the BX term ultimately included only a constant term and a term for the membership fee.

Willingness-to-pay values were evaluated and mean and median values were reported for all subcategories of respondents. For the bald eagle, the median values ranged from a low of $4.92 for noncontributing nonviewers (existence value only) to a high of $24.63 for contributing viewers (existence and use value). The basis year for dollar values was not indicated, but is assumed to 1985.

Species for Which Values were Determined

Bald eagle and striped shiner. Both are listed among Wisconsin's endangered species. The latter is a minnow species whose primary habitat is in sections of the Milwaukee River; it is not classified as a federally threatened or endangered species.

Boyle, Kevin J., Stephen D. Reiling, Mario Teisl, and Marcia L. Phillips. A Study of the Impact of Game and Nongame Species on Maine's Economy, University of Maine, Orono. December 1990.

Data Source(s)

Surveys were conducted to assess the value of consumptive and nonconsumptive uses of wildlife in the state. For inland fishing and hunting, samples were drawn from all residents and nonresidents holding a valid 1987 or 1988 Maine fishing or hunting license. Screening surveys were conducted to identify samples of nonresident and resident marine sport anglers. Finally, a sample frame of Maine heads of households over 18 years of age was purchased to support a survey of nonconsumptive use.

The survey for nonconsumptive use was conducted in two phases. The first phase characterized nonconsumptive uses of fish and wildlife in Maine and was sent to 1,000 randomly selected Maine residents, with a 70 percent response rate. The second phase was used to develop an economic profile of nonconsumptive uses and to identify management actions that would enhance nonconsumptive use opportunities in Maine. The second phase survey was also sent to 1,000 Maine households. The response rate for the second survey was 76 percent.

Methodology

Consumer surplus values were estimated based on willingness-to-pay to increase the size of species populations. The surplus values applied to preservation of the species in Maine, not in the U.S. as a whole. Specifically, surveyed residents were asked to estimate annual willingness-to-pay to increase the Maine bald eagle population from 119 nesting pairs to 200 nesting pairs. The figures reported therefore imply an increase in population of 182 birds.

Results were reported as mean willingness-to-pay figures, with no controls for respondent characteristics. Eighty-six percent of respondents indicated a willingness to increase the population from 109 pairs to 200 pairs; the mean annual surplus value for these respondents was $14 (for an additional 182 eagles). Extrapolating the survey results to the total number of households in Maine resulted in an aggregate annual surplus value of $4,118,000. The basis year for dollar values was not indicated, but is assumed to be 1989.

Species for Which Values were Determined

Bald eagles. Other data were obtained for collectively preserving ten endangered species in Maine, including: bald eagles, peregrine falcons, roseate terns, right whales, humpback whales, finback whales, sperm whales, sei whales, letherback turtles, and Atlantic ridley turtles. However, these other data were not reported.

Brown, Gardner Mallard, Jr., and Judd Hammack. Commonwealth of Virginia vs. Steuart: Economic Valuation of Waterfowl, unpublished testimony/deposition of May 5, 1977.

Data Source(s)

The authors used data and regression coefficients from Hammack and Brown (1974) for consumptive values of waterfowl. Nonconsumptive use values for waterfowl were derived from recreational use data from the State of Virginia, user-day values from the U.S. Fish and Wildlife Service, and estimates of the cost of rehabilitating oiled birds.

Methodology

The document describes a specific application of the waterfowl consumptive use estimation method described in Hammack and Brown (1974) to an oil spill damage recovery case in the Chesapeake Bay. Methodology and data developed for a Pacific flyway case were adjusted to reflect conditions and species along the Atlantic flyway. The mathematical form for expressing the marginal valuation of a individual waterfowl was the following:

$$\text{Marginal valuation} = 4.49\, I^{0.443}\, S^{0.163}\, C^{0.149}\, W^{-0.591}$$

Where "I" is household income, "S" is years of hunting experience, "C" represents hunting expenditures, and "W" is number of waterfowl bagged per season. Average values for Atlantic flyway conditions at the time of the Chesapeake Bay spill (1976) were substituted in the above equation to yield a use value per waterfowl of $16.72.

Values for nonconsumptive use were derived from data on recreational use of the area around the spill for the period July 1973 to June 1976. A simple regression of total visits per month on numbers of waterfowl yielded a figure for marginal visits/bird of 0.2099. The value of a recreation day, $7.50, was calculated by adjusting for inflation the mean figure for a recreation day as reported by the Federal Water Resources Council. Total damages were assessed assuming a four-month viewing season, and further assuming that half of the lost population would recover naturally after one year, three-quarters after two years, and full equilibrium would be restored at the end of the third year. Annual values per lost bird for the first year were reported as $2.25, in 1976 dollars.

Existence value was estimated separately to be $15.00 per bird. This value was based on the cost to successfully treat birds damaged by oil, as reported in the Commonwealth of Virginia Hearings on the Chesapeake Bay Oil Spill. The methodology used to obtain this value was not reported. All results were reported in 1976 dollars.

Species for Which Values were Determined

The estimates apply generally to waterfowl species killed in the spill, including ducks, geese, coots, grebes, old squaws, and whistling swans.

Charbonneau, J. John and Michael J. Hay. "Determinants and Economic Values of Hunting and Fishing," U.S. Fish and Wildlife Service. 1978.

Data Source(s)

Utilizes the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation. The survey consisted of telephone interviews with 106,000 households to assess levels of recreational activity (Phase I). In addition, a mail survey follow-up to hunters and anglers was conducted to gather more detailed data on hunting and fishing activities (Phase II). The survey contains usable information from over 320,000 individuals from Phase I and over 20,000 individuals from Phase II.

Methodology

The authors applied two methodologies to estimate the consumer surplus accruing to individuals participating in hunting and fishing activities: a direct question, willingness-to-pay survey; and a revealed preference approach (similar to a travel cost model). The direct question method employed willingness-to-pay user day values from the National Survey as dependent variables in log-linear specified regression models. These regression models take one of two forms:

$V = f(YEARS, COST, INC, SUBST, DAYS, BAG/DAY)$ (I)
$V = f(YEARS, COST, INC, SUBST, BAG)$ (II)

"V" is the individual's consumer surplus for a season of his favorite activity. "YEARS" represents the number of years the individual has engaged in that activity. "COST" measures the cost of the activity in 1975. "INC" is gross household income in 1975. "DAYS" is days of participation and "BAG" is seasonal harvest for the favorite activity in 1975; "BAG/DAY" is the average daily harvest derived from "BAG" and "DAYS." "SUBST" measures willingness-to-pay (COST + V) for the second favorite activity, and is expected to be positively related to V for the favorite activity. The marginal values for an additional day and bag are, respectively, the partial derivative of (I) with respect to "DAYS" and of (II) with respect to "BAG".

An indirect expenditure model was estimated based on reported expenditures. This analysis yielded somewhat higher values for an incremental day or bag than the first method. The dependent variable was the sum of hunting and fishing expenditures in 1975, including an imputed measure of the opportunity cost of time based on McConnell (1975). Results were reported in 1975 dollars.

Species for Which Values were Determined

Various fish and game species. In some cases values were determined for specific species (deer, wild turkey), but for the most part estimates were made for broader classes of species (waterfowl or sea-run fish).

Cocheba, Donald J. and William A. Langford. "Wildlife Valuation: The Collective Good Aspect of Hunting," Land Economics, 54(4) 490-504. 1978.

Data Source(s)

A multi-purpose survey of all households in Saskatchewan Province, Canada, included some questions designed by the authors for this study. Household members were asked to estimate time spent hunting waterfowl, number of shots taken, and willingness-to-pay for waterfowl hunting activities. Of the surveys returned, 169 contained answers to the hunting activities section.

Methodology

Cocheba and Langford estimate the annual value of waterfowl to hunters. The authors expand on Hammack and Brown's methodology (1974) by incorporating a public good aspect of bird value. Essentially, the authors' value is the sum of the value of a bagged bird and the value the bird imparts as a target for missed shots. The following model is used:

$$V = V\ (Y,U,D/H,S/H,H)$$

Where V is household willingness-to-pay for hunting activities per season, Y is household income, U is seasons of household hunting experience (a taste variable), D is the household's total bagged waterfowl in a given season, H is total hours spent hunting by all household members, and S is shots fired at waterfowl that missed. A logarithmic form provided the best fit to the data.

Results are reported as the marginal value of an additional bagged waterfowl ($1.30) and the marginal value of an additional missed shot ($0.26). These are the first partial of V with respect to D/H, divided by H, and the first partial of V with respect to S/H, divided by H, respectively. The actual value of an additional bird is calculated based on the number of additional birds, the number of bags this yields, and the kill probability P(D). P(D) is the conditional probability of bagging a bird when a shot is taken. Using the author's value of P(D)=0.15, there will be 6.6 shots fired for each bird bagged. If 300 additional birds yield 100 additional bags, they will also yield 660-100=560 additional missed shots. The value of each additional bird (in the first season) is:

$$((100 * 1.30) + (560 * .26)) / 300 = \$0.92$$

This is over twice the result when the computation is based only on the value of a bagged bird.

The basis year for dollar values was not indicated, but is assumed to be 1975 [Canadian].

Species for Which Values were Determined

The model provides results for waterfowl as a broad class, not for individual species.

Hageman, Ronda. Valuing Marine Mammals Populations: Benefit Valuations in a Multi-Species Ecosystem, National Marine Fisheries Service. 1985.

Data Source(s)

A mail survey of 1,000 California residents was conducted. Names and addresses were chosen randomly from telephone directories, using a sampling scheme that weighted by population distribution within the state. The mailings contained descriptions and pictures of four marine mammal species, population data for the animals, and a questionnaire. Data were collected on travel cost for marine mammal viewing, willingness-to-pay to avoid a specified decrease in the population of each species, and socio-economic indicators. The hypothetical payment vehicle for the willingness-to-pay response was a preservation fund to protect marine mammals. An overall response rate of 21 percent was achieved.

Methodology

A model was constructed to evaluate the effect of the various combinations of independent variables on willingness-to-pay. This model took the following form:

WTP = f(EXP, MC, FSZ, AGE, Y, AV2)

Where "WTP" represents willingness-to-pay to avoid a decrease in species population, "EXP" represents a measure of exposure to the species, "MC" represents the distance of the town of residence to the California coast, "FSZ" is family size, "AGE" is the age of respondent, "Y" is household income, and "AV2" represents a measure of interest in species preservation/conservation.

Valuation estimates were not generated using this model, but were derived directly from the response data. For example, values for sea otters represented mean willingness-to-pay per household to avoid a reduction of the California sea otter population from the present 1,500 to 100, the historical low. The basis year for dollar values was not indicated, but is assumed to be 1984.

The response rate for the travel cost portion of the survey was very low. As a result, data were insufficient to justify an analysis using a travel cost model framework.

Species for Which Values were Determined

California sea otters, gray whales, blue whales, and bottlenose dolphins.

Halter, Faith and Joel T. Thomas. "Recovery of Damages by States for Fish and Wildlife Losses Caused by Pollution," Ecology Law Quarterly, 10:5-35. 1982.

Data Source(s)

Studies conducted to develop restitution values for the State of Virginia.

Methodology

Halter and Thomas' work is essentially a law review literature search that describes methods for developing restitution values. A short list of restitution values for the state of Virginia are included in an appendix to the article. Bald eagle and osprey values are the highest reported ($5,000), the kingfisher the lowest ($50). The basis year for these dollar values was not indicated in the document, but is assumed to be 1985.

Species for Which Values were Determined

Bald eagle, osprey, belted kingfisher, atlantic sturgeon, wolverine, and mountain goat.

Hammack, Judd and Gardner Mallard Brown, Jr. Waterfowl and Wetlands: Toward Bioeconomic Analysis, Resources for the Future. 1974.

Data Source(s)

Questionnaires were mailed to 4,900 hunters in the Pacific Flyway states of Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. Hunters were randomly selected from a list provided by the U.S. Bureau of Sport Fisheries and Wildlife. The list consisted of duck stamp purchasers for the 1967-68 season. Data were collected on the number of seasons spent hunting, species preference, number of waterfowl bagged in the 1967 and 1968 seasons, days spent hunting per season, costs attributable to hunting activities, age, education, household size, and household income. In addition, hunters were asked to estimate their willingness-to-pay and willingness-to-accept-compensation for hunting activities. 1,511 responses were useable.

Methodology

Hammack and Brown estimated the marginal value of waterfowl to hunters. Their model takes the following form:

$$V = V(Y, S, E, D/Z, Z)$$

where "V" is a measure of consumer's surplus, "Y" is income, "S" is number of seasons experience, "E" is the annual cost of hunting, "D" is one hunter's bagged waterfowl for the season, and "Z" is the number of days the individual hunted during the season. "S" and "E" are taste variables. A logarithmic form provided the best fit to the data.

Results were presented as three measures of the marginal valuation of waterfowl: the first partial of V with respect to D/Z, divided by Z; the first partial of V with respect to Z, divided by D/Z; and the first partial of V with respect to D. The last measure was derived from a slightly different model from that given above, that substitutes D for D/Z and Z. The first measure is the "quality margin", or the marginal value of an additional waterfowl holding constant the number of days. The second measure is the "quantity margin", the marginal value holding constant the number of waterfowl killed on each hunting day. The last measure is a simple marginal value calculation. Results ranged from a high of $5.21 for the quantity margin to a low of $2.38 for the quality margin. Results were reported in 1968 dollars.

Species for Which Values were Determined

Results apply to all hunted waterfowl species in the Pacific flyway. The majority of the birds bagged in the Pacific flyway consists of mallards and pintails. Attempts to disaggregate the results among duck, geese, and other game species were unsuccessful.

Hammack, Judd and Gardner Mallard Brown, Jr. "A Preliminary Investigation of the Economics of Migratory Waterfowl". 1972. As described in John V. Krutilla and Anthony C. Fisher. The Economics of Natural Environments, Resources for the Future. 1975.

Data Source(s)

Questionnaires were mailed to 4,900 hunters in the Pacific Flyway states of Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. Hunters were randomly selected from a list provided by the U.S. Bureau of Sport Fisheries and Wildlife. The list consisted of duck stamp purchasers for the 1967-68 season. 1,511 responses were useable.

Methodology

Hammack and Brown estimated the marginal value of waterfowl to hunters as part of a model of the optimal allocation of waterfowl breeding habitat and waterfowl. Their "optimal control model" maximizes the difference between the total hunter valuation of waterfowl, estimated by hunters' willingness-to-pay for hunting activities, and the cost of maintaining habitat areas (ponds), subject to the constraint of a waterfowl production function. The first stage of the model is an estimation of a willingness-to-pay model very similar to that described in Hammack and Brown (1974). The model took the following form:

$$V = V(Y, S, E, K)$$

where "V" is a measure of consumer's surplus, "Y" is income, "S" is number of seasons experience, "E" is the annual cost of hunting, and "K" is one hunter's bagged waterfowl for the season. "S" and "E" are taste variables. A logarithmic form provided the best fit to the data.

The results of this regression were then used to estimate stationary economic optimal values for the number of breeding waterfowl, the acreage of ponds, the marginal value of waterfowl to hunters, and the total waterfowl kill. Assumptions included a discount rate of 8 percent, a 95 percent waterfowl summer survival rate, an 84 percent waterfowl fall and winter survival rate, (for those waterfowl not killed by hunters), and an adjustment factor for unbagged kill of 1.25. The optimal marginal value of waterfowl varied with the assumption concerning the cost of maintaining ponds for wildlife habitat. Pond cost assumptions of $4.76, $12.00, and $17.00 per pond (about 0.85 acres) resulted in marginal values of waterfowl of $1.90, $3.10, and $3.70, respectively. The estimate for marginal value of waterfowl applied to the total waterfowl population, including bagged birds, unbagged kill, and birds that escaped harvest. The basis year for dollar values was not indicated, but is assumed to be 1968.

Species for Which Values were Determined

Results apply to all hunted waterfowl species in the Pacific flyway. The majority of the birds bagged in the Pacific flyway consists of mallards and pintails.

Meyer, Philip A. The Value of King Salmon, Harbor Seals, and Wetlands of San Francisco Bay, The Bay Institute of San Francisco. 1987.

Data Source(s)

A telephone survey of 1,157 households in the San Francisco Bay area and 300 households in the Sacramento area was conducted in 1986. The survey asked respondents to state willingness-to-pay to avoid a 10 percent decline in the San Francisco Bay harbor seal population (representing a loss of about 30 seals). The question was posed for each of two hypothetical conditions: unknown cause of decline and decline attributable to toxic pollutants. A total of 4,625 telephone contact attempts were made; of this number, 2,486 found residents at home. The overall contact percentage was therefore 54 percent. Of the 2,486 successful contacts, 1,157 or 59 percent, resulted in completed interviews.

Methodology

Attempts to model willingness-to-pay based on respondent attributes proved unsuccessful. Therefore, results were presented as mean willingness-to-pay per household for Bay area and Sacramento area respondents, for each of the two causal conditions. The results were presented under a strategy designed to eliminate protest bids by excluding bids above $10,000. Protest bids, so defined, represented between one and eight percent of the samples by county, and about five percent of the overall sample. Mean willingness-to-pay ranged from $108.03/household in Alameda County to $362.47/household in San Francisco County.

Species for Which Values were Determined

Harbor seals. Other parts of the survey were designed to evaluate willingness-to-pay to avoid losses or cause gains in chinook salmon populations or in the number of wetland acres around San Francisco Bay. A similar method was used for the chinook salmon estimate, however four population change scenarios were analyzed as opposed to the one analyzed for harbor seals.

North Carolina Administrative Code, Wildlife Resources and Water Safety. Title 15: 10B.0117, Replacement Costs of Wildlife Resources. 1980.

Data Source(s)

Unknown

Methodology

Restitution values based on the following ten factors: whether the species is classified as endangered or threatened; the relative frequency of occurrence of the species in the state; the extent of existing habitat suitable for the species in the state; the dependency of the species on unique habitat requirements; the cost of acquiring, by purchase or long-term lease, lands and waters for habitat development; the cost of improving and maintaining suitable habitat for the species on lands and waters owned or acquired; the cost of live-trapping the species in areas of adequate populations and transplanting them to areas of suitable habitat with low populations; the availability of the species and the cost of acquisition for restocking purposes; the cost of rearing in captivity those species that, when released, have a probability of survival in the wild; the ratio between the natural life expectancy of the species and the period of its probable survival when, having been reared in captivity, it is released to the wild; and the change in the value of money between the effective date of these regulations and the time of injury as reflected by the consumer price index.

Species for Which Values were Determined

North Carolina's bird and mammal species.

O'Brien, K. and D.R. Talhelm. "Survey of State and Provincial Restitution Values." 1990.

Data Source(s)

Species specific restitution values used by 48 states, 11 provinces of Canada, the Canadian Federal government, Guam, and the Virgin Islands. Values were taken from documents produced by the various government agencies responsible for developing these values.

Methodology

This source is essentially a database. No adjustment of the values was made. The appropriate basis year for dollar values is given in the database.

Species for Which Values were Determined

A wide variety of game and non-game species, dependent on the individual agency needs for restitution values.

State of Minnesota, Department of Natural Resources, Divisions of Fish and Wildlife and Enforcement. In the Matter of the Proposed Adoption of Rules Prescribing Restitution Values for Fish and Wildlife Illegally Killed, Injured, or Possessed: Statement of Need and Reasonableness, State of Minnesota, Department of Natural Resources. 1991.

Data Source(s)

Recommended restitution values from Talhelm (1990).

Methodology

This document served to adjust and make final the restitution values for Minnesota species recommended by Talhelm (1990). Dr. Talhelm's recommended values were adjusted by incorporating the professional judgement of Department of Natural Resources (DNR) personnel and by incorporating assumptions relevant to commonly encountered restitution situations (e.g., poaching). For example, Talhelm's recommended value for bear included the market value of a bear pelt. Because the state routinely sells any marketable pelts that are confiscated and thus recovers the value of the pelt, the final restitution value adopted by the state excluded the value of the pelt. For trumpeter swans, the state assumed that Talhelm's recommended value underestimated both the true cost of replacement of species and the value of the species to state residents, and thus adjusted this value upward by 50 percent. Similar adjustments were made for other values based on management costs associated with state repopulation programs and costs of purchasing suitable habitat.

Species for Which Values were Determined

All Minnesota fish, bird, and mammal species.

Sterling Hobe Corporation. "Resource Damage Assessment of the T/V *Puerto Rican* Oil Spill Incident," as cited and described in James Dobbin Associates Incorporated. April 1986.

Data Source(s)

Twenty-three institutions were asked to estimate the cost of obtaining specimens or, alternatively, the price they would be willing to sell specimens for. Nine institutions responded, although not every institution provided a comprehensive set of all requested species values.

Methodology

Sterling Hobe Corporation and James Dobbin Associates used these data as proxies for replacement cost, and applied the prices to the damage assessment for the *Puerto Rican* spill. The authors used the second highest and second lowest reported prices for each species to bracket the range of replacement cost. A conservative estimate of total damages attributable to marine bird destruction was calculated by multiplying the number of confirmed dead birds by the low end of this range (the second lowest reported price). The basis year for the dollar estimates is not indicated in the document, but is assumed to be 1985.

Species for Which Values were Determined

Approximately 30 marine bird species affected by the *Puerto Rican* oil spill incident.

Talhelm, Daniel R. "Recommended Values for Computing Fair Restitution to the Citizens of Minnesota for Fish and Wildlife Illegally Killed, Injured or Possessed." 1990.

Data Source(s)

Primarily literature values, supplemented with data on state restitution values from 33 states (O'Brien and Talhelm 1990), and public comment (public hearings to assess the "reasonableness" of the values to Minnesota residents).

Methodology

Talhelm estimated restitution values for damage to wildlife caused by environmental pollution for use in legal proceedings in Minnesota. His methodology is based on aggregation and modification of literature-based values for willingness-to-accept, willingness-to-pay, and replacement values. Talhelm reviewed about 400 estimates of fish and wildlife values, representing a wide variety of supply and demand conditions throughout the U.S. and parts of Canada. Some of these estimates were modified, based on correction factors suggested by other authors (Sorg and Loomis 1985, Walsh et al. 1988, Reily and Rockland 1988), to reflect conditions in Minnesota.

Talhelm's approach varies slightly for different species, because of differences in data availability, but the basic methodology was consistent. Total restitution value was computed as the sum of seven categories of value: recreational and subsistence hunting, viewing and non-consumptive use, existence, option, commercial market, special ecological role, and nuisance. Nuisance costs were subtracted from the sum of the other categories. The author considered the potential for overlap between categories and in some cases considered a category to be subsumed within another estimate. Where direct literature values were not available for a species Talhelm interpolated a value from other species values.

Recreational and subsistence hunting values made up the largest part of total value for most species. Talhelm began with values for the average hunter day, converting them to species values by multiplying by the number of hunter days per animal in the Minnesota population. He ignored values of average valuation per animal harvested because he found they were not well supported in the literature.

Talhelm interpreted restitution value as a willingness-to-accept-compensation. He therefore converted literature values for willingness-to-pay to willingness-to-accept by multiplying the former values by four. This conversion factor was based on the results of Knetsch and Sinden (1984) and Knetsch (1989), and in Talhelm's view represented a conservative assumption when viewed in light of other evidence on the relationship between willingness-to-pay and willingness-to-accept. Estimates of consumer surplus from travel cost models were converted with a more conservative factor of three, reflecting a judgement that a small number of travel cost models actually estimate willingness-to-accept. Recreational and subsistence hunting estimates were also adjusted downward to reflect the fact that most restitution cases involved a small change in population, as opposed to the all-or-nothing situation assumed in many of the studies. Finally, values were adjusted upward by a factor of two, since an animal is not immediately replaced after one year, and the literature values are computed on an annual basis. For slower growing species, this factor was slightly higher.

Viewing and non-consumptive use values are derived from a combination of U.S. Department of Interior estimates (USDOI 1987), and literature values. Where Interior data are lacking, Talhelm interpolates from similar species values. This category of value ranges from "small" for some fish to $20,000 for eagles, but is generally in the $1 to $15 range. Existence and option values are assumed to be small for all species except those that are endangered. Small option values are incorporated into the total value for some species, but reflect the judgement of the author rather than empirical evidence.

In all cases, the derived values reflect two basic assumptions: only one or a few animals are lost; and the individuals lost are typical or average animals. Except in cases of trophy animals and endangered or rare species, the values do not account for specific locational or individual attributes of species (e.g., difficulty of replacement in the wild due to unique social characteristics of individual animals). The values derived in this study tend to fall in the middle range of restitution values used by 33 other states for which similar estimates were available. Results were reported in 1989 dollars.

Species for Which Values were Determined

Mostly game species of mammals and birds, along with an extensive list of fish species. Values for some threatened or endangered species were estimated as well (bald eagle, wolf).

U.S. Fish and Wildlife Service, Division of Law Enforcement. "Market Values for Illegally Traded Wildlife." 1990.

Data Source(s)

Newspaper and magazine reports, foreign governments, U.S. Fish and Wildlife legal files, and non-profit organizations.

Methodology

This document is essentially a listing of market values for illegally traded wildlife compiled from a variety of sources. This information is reported on a per individual or per animal part basis (e.g., hides or antlers), for individual species. Values were not adjusted to account for numbers of individuals involved in the trade or other conditions surrounding the trade. The year the market value was reported is indicated in the database.

Species for Which Values were Determined

The database contains values for about 60 species of all types, mostly mammals and birds, but also including some fish, shellfish, insects, and plants.

Walgenbach, Frederick E. "Economic Damage Assessment of Flora and Fauna Resulting from Unlawful Environmental Degradation," California Department of Fish and Game. 1979.

Data Source(s)

Literature values; no new data were collected.

Methodology

Walgenbach derived total value as the sum of replacement, use, and existence values. Replacement value was based on the cost of captive or natural area breeding of broad classes of species. Values were adjusted by a series of factors reflecting difficulty of breeding, number of offspring, length of breeding cycle, and specificity of habitat requirements. These factors are whole number values.

To determine use value for individual species, first a total annual use value for all species was estimated by multiplying total wildlife-viewing recreation days in the state by user-day values for wildlife viewing.[1] Next, the bird viewing total value was allocated equally among the 400 species of birds found in California and the mammal-viewing total was allocated among the 220 mammal species. This yielded a total value per species for all individuals in a species. Per animal values were then assigned to individuals of each species by dividing by the midpoint of the species' population size class. Five population classes were generated for big game, small game, and birds. For example, if a bird species had a California population of 4,500 individuals, it is assigned first to the population class or "1,000 to 10,000." The total value of the species is then divided by the midpoint of this range. This method results in higher values per individual for species least likely to be seen by the recreationalist.

A similar method was used to determine existence values. A total existence value estimate derived from literature values was allocated first to each species, then to individuals according to the species' population class. Per day existence values were drawn from Horvath (1974).[2] Results were reported in 1978 dollars.

Species for Which Values were Determined

400 species of birds and 220 species of mammals, representing virtually all species found in the state of California. Walgenbach does not consider rare or endangered mammals.

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[1] Recreation day values were taken from Brown (1978).

[2] Total per day consumption (willingness-to-accept) for wildlife viewing in Horvath's work is $119 for birds, $157 for animals, and $132 for fish.

Walsh, Richard G., Donn M. Johnson, and John R. McKean. "Issues in Nonmarket Valuation and Policy Application: A Retrospective Glance," Western Journal of Agricultural Economics, 14(1):178-188. 1989.

Data Source(s)

Literature values of the demand for outdoor recreation, measured in terms of nonmarket benefits, and published from 1968-1988.

Methodology

Results were obtained from 287 studies of demand for outdoor recreation, reported as the value of a visitor day. Results were categorized according to National Forest Recreation Use Categories, to produce estimates of the net economic value of a visitor day for each category (e.g., migratory waterfowl hunting and nonconsumptive fish and wildlife). In each category where a sufficient number of studies warranted the calculation, a mean, median, standard error of the mean, and 95 percent confidence interval were calculated. Ranges were also reported. The authors suggested that, in applying these results to other analyses, median values are preferable to means, especially if the purpose of the analysis is to obtain a representative estimate. All results were reported in 1987 dollars.

Species for Which Values were Determined

Species-specific values are not determined. Results are reported for: big game hunting, small game hunting, migratory waterfowl hunting, cold water fishing, warm water fishing, salt water fishing, and nonconsumptive fish and wildlife.

Williams, Terrie M. and Randall W. Davis. "Sea Otter Rehabilitation Program: 1989 Exxon Valdez Oil Spill", sponsored by Exxon Company USA. 1990.

Data Sources

Actual Exxon expenditures to support the sea otter rehabilitation program from March 24, 1989 to September 15, 1989. The authors derived the total cost figure of $18.3 million as the sum of salaries for staff ($5.9 million), the cost of constructing rehabilitation centers ($4.2 million), boat and aircraft charters ($3.2 million), supplies and operations ($3.3 million), sea otter food ($0.95 million), and aquariums and miscellaneous costs ($0.75 million).

Methodology

This report documents the total number of otters treated (357) and the total number of otters actually rehabilitated and released (225), but does not present per otter values based on these data. Values reported in Exhibit 1 of this document reflect total costs divided by the number of treated otters and the number of rehabilitated otters.

Species for Which Values were Determined

Sea otters.

Appendix B

U.S. HISTORIC INFLATION RATE

Appendix B

U.S. HISTORIC INFLATION RATE

Year	Implicit Price Deflator Using U.S. GNP (1982 = 100)	Year to Year Change
1968	37.7	NA
1969	39.8	5.6%
1970	42.0	5.5%
1971	44.4	5.7%
1972	46.5	4.7%
1973	49.5	6.5%
1974	54.0	9.1%
1975	59.3	9.8%
1976	63.1	6.4%
1977	67.3	6.7%
1978	72.2	7.3%
1979	78.6	8.9%
1980	85.7	9.0%
1981	94.0	9.7%
1982	100.0	6.4%
1983	103.9	3.9%
1984	107.7	3.7%
1985	110.9	3.0%
1986	113.8	2.6%
1987	117.4	3.2%
1988	121.3	3.3%
1989	126.3	4.1%
1990	131.5	4.1%
Source: Economic Report of the President, February 1990.		