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G. A. Langer

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Oil Vulnerability Index for Marine Oriented Birds

by

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Abstract

The 176 species of birds using marine habitats of the Northeast Pacific are graded on the basis of 20 factors that affect their survival. A score of 0, 1, 3, or 5, respectively, representing no, low, medium, or high significance is assigned for each factor. The total score is the Oil Vulnerability Index (OVI). The OVI's range from 1 to 100, an index of 100 indicating the greatest vulnerability. Using this system, one can rank the avifauna of different areas according to their vulnerability to environmental hazards as an aid in making management decisions.

Today's decision makers require an ever-increasing array of information and planning documents. The Federal Government's requirement for environmental impact statements under the National Environmental Protection Act of 1969 is but one example of this trend. These documents generally consider the effects of proposed actions on waterfowl and a few other species of birds, but the bulk of the avifauna is usually only listed, or sometimes ignored completely. A simple system for evaluating and presenting avian data is badly needed so that those interested in birds, whether technically trained or not, can easily grasp the implications of proposed actions. It is incumbent on biologists to devise new ways of presenting their knowledge so that it can be easily and effectively used by decision makers, who are often less informed. In short, biologists must do for the environmental impact statement assessors what Roger Tory Peterson did for the bird watchers by giving them a simple and comprehensible system.

The need for a system to evaluate relative vulnerabilities of bird populations is particularly great for birds that are being increasingly affected by marine oil pollution. The system needs to allow comparisons of potential impacts to birds resulting from various oil development projects in different locations and served by various modes of transport. The Oil Vulnerability Index (OVI) is our attempt to fulfill this informational need on the avifauna of the Northeast Pacific. Insofar as we know, this approach to assessing a wildlife management problem has been attempted only for ranking endangered species in a numeric ranking system that identified where restoration efforts could best be directed (Sparrowe and Wight 1975).

We are indebted to Gene Ruhr and Keith Schreiner for ideas generated in their work with endangered species. Frank Pitelka, James Bartonek, Kent Wohl, and Mary Lou King reviewed portions of the manuscript and offered helpful suggestions. Jack Hodges helped prepare the OVI tables.

Methods

A list of 176 species of birds using marine habitats in or near the States of Washington and Alaska and the Province of British Columbia (Table 1, left column) was compiled from checklists by the American Ornithologists' Union (AOU 1957) and Gibson (1970). Nomenclature is from AOU (1957). The scientific names of three species of shorebirds recently identified in the Aleutian Islands that were not listed by the AOU (1957) came from Peterson et al. (1967).

Each bird was scored on 20 factors that affect its survival (Table 1). Point scores for most birds were either 0, 1, 3, or 5, indicating no, low, medium, or high importance, respectively, in their biology or habits as related to Northeast Pacific oil development. Rare or accidental species were given only one point for occurrence, and endangered species 99 points for population size plus 1 point for occurrence. Thus the potential range of the OVI's is from 1 to 100.

The factors in Table are largely self-explanatory. The items under "range" apply to the entire world population of the species. "Productivity" is derived from a combination of clutch size and age at first nesting. Specialization is used in the biological sense to compare a versatile species like mallards (*Anas platyrhynchos*) with a less versatile species such as the trumpeter swan (*Olor buccinator*). Mortality under "history of oiling" is based on our knowledge that some species (e.g., alcids) have been more involved than others such as gulls. Exposure relates to the level of exposure within the Pacific area in any season.

Information on many of the factors for many species is scanty at best, and subjective appraisals were made by us when information was lacking. Opinions as to appropriate scores will vary among experts. References used, in part, in preparing Table 1 were: AOU 1957; Fay and Cade 1959; Gabrielson and Lincoln 1959; Isleib and Kessel 1973; Kortright 1942; Murie 1959; Palmer 1962; Robbins et al. 1966; Sanger 1972; and Stout et al. 1967.

Results

The OVI for each of 176 bird species is listed in Table 1. The average OVI for 22 avian families comprising 128 species that are neither rare stragglers nor endangered ranged from 19 to 88, with a mean of 51 (Table 3).

Tables 4 and 5 show a possible use for the OVI by comparing impacts in two large, widely separated areas. A species list from Southeast Alaska (U.S. Forest Service and Alaska Department of Fish and Game 1970) is compared with a list from the Aleutian Islands (U.S. Fish and Wildlife Service 1974). Only commonly occurring species are included. These tables graphically display rather strong differences in the vulnerability of the avifauna of each area. A person explaining comparative impacts of projects might use the tables in the following way:

- Column 1, with scores from 1 to 20 points, indicates birds with a low level of project involvement, where damage or future costs would not be expected. As this will normally be the longest list, as in Tables 4 and 5, one would expect an immediate rise of interest on the part of the planning agency, which is probably eager to learn where problems will be fewest.

- Column 2 (21 to 40 points) indicates birds for which there is a low level of concern. Perhaps all that is needed is a review to determine if special characteristics of the project might be detrimental to these species.

- Column 3 (41 to 60 points) might be called "trial and error" species. If some birds are adversely affected, it will not be catastrophic. As the project develops it will be merely necessary to monitor these to make sure their status is not adversely affected. If it is, there will be time to develop conservation measures.

- Columns 4 and 5 (61 to 80 points and 81 to 100 points, respectively) include the species where concern is high. It is for these species that research money will be needed, where project modifications may be required, where a contingency plan in case of disaster is needed, where a conservation technology will

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Table 1. *Oil Vulnerability Index (OVI) for waterbirds in the Northeast Pacific Region.*

Family, common (AOU) name and scientific name	Range: B Breeding range size; M Migration length; W Winter range size; Mo Marine orientation				Population: Po Population size; Pr Productivity		Habits: R Roosting; Fo Foraging; E Escape; Fl Flocking on water; N Nesting density; S Specialization						Mortality: H Hunted by man; A Animal depredations; N Non-oil pollution; P History of oiling				Annual exposure: Sp Spring; Su Summer; F Fall; W Winter				OVI: Total points
	B	M	W	Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	
Gaviidae																					
Common loon (*Gavia immer*)	1	3	3	3	1	5	5	5	5	1	1	3	1	1	3	3	1	0	1	1	47
Yellow-billed loon (*G. adamsii*)	3	3	5	3	5	5	5	5	5	1	1	3	1	1	0	3	5	1	5	5	65
Arctic loon (*G. arctica*)	3	3	3	3	3	5	5	5	5	1	1	3	1	1	3	3	3	1	3	3	58
Red-throated loon (*G. stellata*)	1	3	3	5	1	5	5	5	5	1	1	3	1	1	3	3	1	0	1	1	49
Podicipedidae																					
Red-necked grebe (*Podiceps grisegena*)	1	3	3	3	1	3	5	5	5	1	1	3	0	1	3	3	1	0	1	1	44
Horned grebe (*P. auritus*)	1	3	3	3	1	3	5	5	5	3	1	3	0	3	3	3	1	0	1	1	48
Western grebe (*Aechmophorus occidentalis*)	3	3	3	5	1	3	5	5	5	5	1	3	0	1	3	5	1	0	1	3	56
Diomedeidae																					
Short-tailed albatross (*Diomedea albatrus*)					99															1	100
Black-footed albatross (*D. nigripes*)	5	1	1	5	3	5	5	3	3	1	5	5	0	0	1	3	1	1	1	1	50
Laysan albatross (*D. immutabilis*)	5	1	1	5	3	5	5	3	3	1	5	5	0	0	1	3	1	1	1	3	52
Procellaridae																					
Fulmar (*Fulmarus glacialis*)	3	3	1	5	1	5	5	3	3	3	5	3	0	1	1	3	3	3	3	3	57
Pink-footed shearwater (*Puffinus creatopus*)	3	1	1	5	1	5	5	3	3	3	5	3	0	1	1	3	1	1	1	1	47
Pale-footed shearwater (*P. carneipes*)																				1	1
New Zealand shearwater (*P. bulleri*)																				1	1
Sooty shearwater (*P. griseus*)	1	1	1	5	1	5	5	3	3	5	5	3	1	1	1	3	1	5	1	0	51
Slender-billed shearwater (*P. tenuirostris*)	1	1	3	5	1	5	5	3	3	5	5	3	1	1	1	3	1	5	1	0	53
Scaled petrel (*Pterodroma inexpectata*)																				1	1
Cook's petrel (*P. cookii*)																		1			1
Hydrobatidae																					
Fork-tailed storm-petrel (*Oceanodroma furcata*)	3	3	3	5	1	5	5	3	3	3	5	3	0	1	1	3	5	5	5	5	67
Leach's storm-petrel (*O. leucorhoa*)	1	3	1	5	1	5	5	3	3	3	5	3	0	1	1	3	5	5	5	5	63

Table 1. (cont.)

Family, common (AOU) name and scientific name	B	M	W	Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	Total points
Pelecanidae																					
Brown pelican (*Pelecanus occidentalis*)																				1	1
Phalacrocoracidae																					
Double-crested cormorant (*Phalacrocorax auritus*)	1	3	3	3	3	3	1	5	3	1	3	3	0	1	3	5	3		3	5	52
Brandt's cormorant (*P. penicillatus*)	3	3	3	5	3	3	1	5	3	1	3	3	0	1	3	5	3	3	3	3	57
Pelagic cormorant (*P. pelagicus*)	3	3	3	5	3	3	1	5	3	3	3	3	0	1	3	5	5	1	5	5	63
Red-faced cormorant (*P. urile*)	5	3	3	5	3	3	1	5	3	3	3	3	0	1	1	5	5	5	3	3	63
Ardeidae																					
Great blue heron (*Ardea herodias*)	1	3	1	1	3	3	1	1	1	1	3	3	0	1	1	1	1	1	1	1	29
Anatidae																					
Whooper swan (*Olor cygnus*)																				1	1
Whistling swan (*O. columbianus*)	3	3	3	3	3	3	5	3	1	5	1	3	3	1	3	1	3	0	3	0	50
Trumpeter swan (*O. buccinator*)	5	5	3	3	5	3	5	5	1	5	1	5	1	1	3	3	3	0	3	3	63
Canada goose (*Branta canadensis*)	1	3	1	1	5	3	1	1	1	3	1	1	5	1	1	1	1	1	1	1	34
Black brant (*B. nigricans*)	3	3	3	5	3	3	5	5	3	5	3	3	5	1	3	5	3	1	5	3	70
Emperor goose (*Philacte canagica*)	3	5	5	5	3	3	3	3	3	3	3	3	3	1	1	5	5	3	5	5	70
White-fronted goose (*Anser albifrons*)	3	3	3	1	3	3	1	1	1	1	1	1	5	1	3	1	1	1	1	1	36
Snow goose (*Chen hyperborea*)	1	3	1	1	3	3	1	1	1	1	1	1	5	1	3	1	1	1	1	1	32
Mallard (*Anas platyrhynchos*)	1	3	1	1	1	1	1	3	3	3	1	1	5	3	3	1	1	1	1	1	36
Gadwall (*A. strepera*)	3	3	1	1	1	1	1	3	3	3	1	1	5	3	3	1	1	1	1	1	38
Pintail (*A. acuta*)	1	3	1	1	1	1	1	3	3	3	1	1	5	3	3	1	1	1	1	1	36
Common teal (*A. crecca*)																		1			1
Green-winged teal (*A. carolinensis*)	1	3	1	1	1	1	1	3	3	1	1	1	5	3	3	1	1	1	1	1	34
Blue-winged teal (*A. discors*)																		1			1
Cinnamon teal (*A. cyanoptera*)																		1			1
European wigeon (*Mareca penelope*)																		1			1
American wigeon (*M. americana*)	1	3	1	1	1	1	1	3	3	3	1	1	5	3	3	1	1	1	1	1	36
Shoveler (*Spatula clypeata*)	1	3	1	1	1	1	1	3	3	1	1	1	5	3	3	1	1	1	1	1	34
Redhead (*Aythya americana*)	1	3	1	1	5	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	52
Ring-necked duck (*A. collaris*)																	1				1
Canvasback (*A. valisineria*)	1	3	1	1	5	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	52
Greater scaup (*A. marila*)	1	3	1	5	1	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	52
Lesser scaup (*A. affinis*)	1	3	1	3	1	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	50

Ring-necked duck (*A. collaris*)																	1						1
Canvasback (*A. valisineria*)	1	3	1	1	5	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	52		
Greater scaup (*A. marila*)	1	3	1	5	1	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	52		
Lesser scaup (*A. affinis*)	1	3	1	3	1	3	5	5	5	3	1	3	5	1	3	3	1	1	1	1	50		

Table 1. (cont.)

Family, common (AOU) name and scientific name	B	M	W	Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	Total points
Common goldeneye (*Bucephala clangula*)	1	3	1	3	1	3	5	5	5	3	1	3	3	1	3	3	1	1	1	1	48
Barrow's goldeneye (*B. islandica*)	3	3	1	3	1	3	5	5	5	3	1	3	3	1	3	3	3	1	3	3	56
Bufflehead (*B. albeola*)	1	3	1	3	1	3	5	5	5	3	1	3	1	1	3	3	3	1	3	3	52
Oldsquaw (*Clangula hyemalis*)	1	3	1	5	1	3	5	5	5	5	1	3	3	1	1	5	5	3	5	5	66
Harlequin duck (*Histrionicus histrionicus*)	3	5	1	5	1	3	1	3	3	3	1	3	1	1	1	5	5	5	5	5	60
Steller's eider (*Polysticta stelleri*)	3	3	5	5	1	3	5	5	5	5	1	3	3	1	1	5	5	3	5	5	72
Common eider (*Somateria mollissima*)	3	5	3	5	1	3	5	5	5	3	1	3	1	1	1	5	5	3	5	5	68
King eider (*S. spectabilis*)	3	5	3	5	1	3	5	5	5	5	1	3	1	1	1	5	5	3	5	5	70
Spectacled eider (*Lampronetta fisheri*)	5	5	5	5	3	3	5	5	5	5	3	3	1	1	1	5	5	3	5	5	78
White-winged scoter (*Melanitta deglandi*)	3	3	3	3	1	3	5	5	5	5	1	3	3	1	3	5	5	5	5	5	72
Surf scoter (*M. perspicillata*)	3	3	3	3	1	3	5	5	5	5	1	3	3	1	3	5	5	5	5	5	72
Common scoter (*Oidemia nigra*)	3	3	3	3	1	3	5	5	5	5	1	3	3	1	3	5	5	5	5	5	72
Ruddy duck (*Oxyura jamaicensis*)	1	3	1	3	1	1	5	5	5	5	1	5	5	3	3	3	1	0	1	3	55
Hooded merganser (*Laphodytes cucullatus*)	1	3	1	1	3	3	3	5	3	1	1	3	1	1	3	1	1	0	1	1	37
Common merganser (*Mergus merganser*)	1	3	3	3	1	3	3	5	5	3	1	3	3	1	3	3	3	3	3	3	56
Red-breasted merganser (*M. serrator*)	1	3	3	3	1	3	3	5	5	3	1	3	3	1	3	3	3	3	3	3	56
Accipitridae																					
Bald eagle (*Haliaeetus leucocephalus*)	1	5	3	3	5	5	0	1	1	0	1	5	0	0	5	3	5	5	5	5	58
Steller's sea eagle (*H. pelagicus*)																		1			1
Marsh hawk (*Circus cyaneus*)	1	3	1	1	1	3	1	1	1	0	1	1	0	0	1	1	1	0	1	0	19
Pandionidae																					
Osprey (*Pandion haliaetus*)	1	3	1	1	5	5	0	1	1	0	1	5	3	1	5	1	1	1	1	0	37
Falconidae																					
Peregrine falcon (*Falco peregrinus*)	1	3	1	1	5	5	0	1	1	0	1	3	3	0	5	1	3	3	3	1	41
Gruidae																					
Sandhill crane (*Grus canadensis*)	1	3	1	1	1	3	1	1	1	0	1	1	3	1	1	1	1	1	1	0	24
Rallidae																					
American coot (*Fulica americana*)	1	3	1	1	1	1	3	3	1	3	1	1	3	3	3	1	1	0	1	1	33
Haematopodidae																					
Black oystercatcher (*Haematopus bachmani*)	5	5	5	5	3	5	1	1	1	1	1	5	0	1	3	3	5	5	5	5	65
Charadriidae																					
Ringed plover (*Charadrius hiaticula*)																		1			1
Semipalmated plover (*C. semipalmatus*)	1	1	1	1	1	3	1	1	1	1	1	1	0	5	1	1	3	1	3	0	28
Mongolian plover (*C. mongolus*)																				1	1
Killdeer (*C. vociferus*)	1	3	1	1	1	3	1	1	1	1	1	1	0	5	1	1	1	1	1	0	26

Table 1. (cont.)

Family, common (AOU) name and scientific name	B	M	W	Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	Total points
Dotterel (*Eudromias morinellus*)																		1			1
American golden plover (*Pluvialis dominica*)	1	1	1	3	3	3	3	1	1	3	1	3	3	5	0	1	1	0	1	0	35
Black-bellied plover (*Squatarola squatarola*)	1	1	1	5	3	3	1	1	1	3	1	3	3	5	1	3	3	1	3	0	43
Surfbird (*Aphriza virgata*)	5	1	5	5	3	3	1	1	1	3	1	3	0	5	1	3	5	0	5	3	54
Ruddy turnstone (*Arenaria interpres*)	1	1	3	5	3	3	1	1	1	3	1	3	0	5	1	3	3	3	3	0	44
Black turnstone (*A. melanocephala*)	5	3	3	5	3	3	1	1	1	3	1	3	0	5	1	3	5	3	5	3	57
Scolopacidae																					
Common snipe (*Capella gallinago*)	1	1	1	1	1	3	1	1	1	1	1	1	5	5	1	1	1	1	1	0	29
Eurasian curlew (*Numenius arquata*)																		1			1
Whimbrel (*N. phaeopus*)	1	1	1	3	3	3	1	1	1	3	1	3	1	3	1	3	3	1	3	0	37
Bristle-thighed curlew (*N. tahitiensis*)	5	1	1	5	5	3	3	1	1	3	1	1	1	3	1	3	3	1	3	0	45
Eskimo curlew (*N. borealis*)					99													1			100
Upland plover (*Bartramia longicauda*)	1	1	1	0	5	3	1	1	1	0	1	1	3	3	1	0	1	1	1	0	26
Spotted sandpiper (*Actitis macularia*)	1	3	1	1	1	3	1	1	1	1	1	1	0	3	1	1	1	1	1	0	24
Common sandpiper (*Tringa hypoleucos*)																		1			1
Solitary sandpiper (*T. solitaria*)																		1			1
Wood sandpiper (*T. glareola*)																		1			1
Wandering tattler (*Heteroscelus incanum*)	5	1	1	5	5	3	1	1	1	3	1	3	1	3	1	3	5	0	5	0	48
Polynesian tattler (*H. brevipes*)																			1		1
Willet (*Catoptrophorus semipalmatus*)																		1			1
Greater yellowlegs (*Totanus melanoleucus*)	1	5	1	1	3	3	1	1	1	1	1	1	3	3	1	1	1	0	1	0	30
Lesser yellowlegs (*T. flavipes*)	1	5	1	1	3	3	1	1	1	1	1	1	3	3	1	1	1	0	1	0	30
Spotted redshank (*T. totanus*)																		1			1
Greenshank (*Tringa nebularia*)																		1			1
Knot (*Calidris canutus*)	1	1	1	5	5	3	1	1	1	3	1	1	1	3	1	3	3	3	1	0	39
Great knot (*C. tenuirostris*)																		1			1
Rock sandpiper (*Erolia ptilocnemis*)	5	3	3	5	3	3	1	1	1	3	1	3	0	3	1	3	5	5	5	5	59
Sharp-tailed sandpiper (*E. acuminata*)	3	1	3	5	3	3	1	1	1	3	1	3	0	3	3	3	3	0	3	3	46
Pectoral sandpiper (*E. melanotos*)	1	1	3	1	3	3	1	1	1	1	1	1	0	3	1	1	3	3	3	0	32
White-rumped sandpiper (*E. fuscicollis*)																				1	1
Baird sandpiper (*E. bairdii*)	1	3	3	1	3	3	1	1	1	1	1	1	0	3	1	1	3	3	3	0	34
Least sandpiper (*E. minutilla*)	1	3	3	3	1	3	1	1	1	1	1	1	0	3	1	1	3	3	3	0	34
Long-toed stint (*E. subminuta*)																		1			1
Temminck's stint (*Calidrus temminckii*)																		1			1
Rufous-necked sandpiper (*E. ruficollis*)	3	1	3	5	3	3	1	1	1	3	1	1	0	3	1	3	1	1	1	0	36
Curlew sandpiper (*E. ferruginea*)																		1			1

Least sandpiper (*E. minutilla*)																						
Long-toed stint (*E. subminuta*)	1	3	3	3	1	3	1	1	1	1	1	1	0	3	1	1	3	3	3	0	34
Temminck's stint (*Calidrus temminckii*)														3	1	1	3	3	3	0	34
Rufous-necked sandpiper (*E. ruficollis*)																		1			1
Curlew sandpiper (*E. ferruginea*)	3	1	3	5	3	3	1	1	1	3	1	1	0	3	1	3	1	1	1	0	1
																		1			36
																					1

Table 1. (cont.)

Family, common (AOU) name and scientific name	B	M	W	Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	Total points
Dunlin (*E. alpina*)	1	3	1	5	1	3	1	1	1	1	1	1	0	3	3	3	3	3	3	3	41
Short-billed dowitcher (*Limnodromus griseus*)	3	3	3	3	3	3	1	1	1	1	1	3	3	3	1	3	3	3	3	0	45
Long-billed dowitcher (*L. scolopaceus*)	5	3	3	3	3	3	1	1	1	1	1	3	3	3	1	3	3	3	3	0	47
Stilt sandpiper (*Micropalama himantopus*)																		1			1
Semipalmated sandpiper (*Ereunetes pusillus*)	1	3	1	3	1	3	1	1	1	1	1	1	0	3	1	1	3	5	3	0	34
Western sandpiper (*E. mauri*)	5	3	3	5	1	3	1	1	1	1	1	1	0	3	3	3	3	5	3	1	47
Buff-breasted sandpiper (*Tryngites subruficollis*)																		1			1
Marbled godwit (*Limosa fedoa*)																		1			1
Bar-tailed godwit (*L. lapponica*)	3	1	1	5	3	3	1	1	1	3	1	3	3	3	1	3	5	5	3	0	49
Hudsonian godwit (*L. haemastica*)																		1			1
Black-tailed godwit (*L. limosa*)																		1			1
Ruff (*Philomachus pugnax*)																		1			1
Sanderling (*Crocethia alba*)	3	1	1	5	3	3	1	1	1	3	1	3	0	3	1	3	3	3	3	3	45
Spoon-billed sandpiper (*Eurynorhynchus pygmeum*)																		1			1
Phalaropodidae																					
Red phalarope (*Phalaropus fulicarius*)	3	1	1	5	1	3	5	5	1	5	1	5	0	3	1	5	5	3	5	0	58
Wilson's phalarope (*Steganopus tricolor*)																			1		1
Northern phalarope (*Lobipes lobatus*)	3	1	3	5	1	3	5	5	1	5	1	5	0	3	3	5	5	3	5	0	62
Stercorariidae																					
Pomarine jaeger (*Stercorarius pomarinus*)	1	1	1	5	1	3	3	3	1	3	1	3	1	1	1	3	3	3	3	0	41
Parasitic jaeger (*S. parasiticus*)	1	1	1	5	1	3	3	3	1	3	1	3	1	1	3	3	3	3	3	0	43
Long-tailed jaeger (*S. longicaudus*)	1	1	1	3	1	3	3	3	1	3	1	3	1	1	1	3	3	3	3	0	39
Skua (*Catharacta skua*)																				1	1
Laridae																					
Glaucous gull (*Larus hyperboreus*)	1	5	3	3	1	3	3	3	1	3	3	1	0	1	1	1	3	3	3	3	45
Glaucous-winged gull (*L. glaucescens*)	5	1	3	5	1	3	3	3	1	3	5	1	1	1	1	1	5	5	5	3	56
Slaty-backed gull (*L. schistisagus*)																				1	1
Western gull (*L. occidentalis*)	3	1	3	5	1	3	3	3	1	3	5	1	1	1	1	1	3	3	3	3	48
Herring gull (*L. argentatus*)	1	3	1	3	1	3	1	3	1	3	1	1	1	1	1	1	3	3	3	3	38
Thayer's gull (*L. thayeri*)	3	3	5	3	1	3	1	3	1	3	1	1	1	1	1	1	3	1	3	3	42
California gull (*L. californicus*)	3	5	3	3	1	3	3	3	1	3	1	1	1	1	1	1	1	1	1	1	38
Ring-billed gull (*L. delawarensis*)	1	5	3	3	1	3	3	3	1	3	1	1	1	1	1	1	1	1	1	1	36
Mew gull (*L. canus*)	1	5	3	3	1	3	3	3	1	3	1	1	1	1	1	1	3	3	3	3	44
Black-headed gull (*L. ridibundus*)																		1			1
Franklin's gull (*L. pipixcan*)																		1			1

Table 1. (cont.)

Family, common (AOU) name and scientific name	B	M		Mo	Po	Pr	R	Fo	E	Fl	N	S	H	A	N	P	Sp	Su	F	W	Total points
Bonaparte's gull (*L. philadelphia*)	1	5	3	3	1	3	3	3	1	3	1	1	1	1	1	1	3	1	3	1	40
Heerman's gull (*L. heermanni*)																				1	1
Ivory gull (*Pagophila eburnea*)	1	5	3	5	3	3	3	3	1	3	1	3	0	1	1	1	1	1	1	3	43
Black-legged kittiwake (*Rissa tridactyla*)	1	3	3	5	1	3	3	3	1	3	5	3	0	1	1	1	3	3	3	3	49
Red-legged kittiwake (*R. brevirostris*)	5	5	5	5	3	3	3	3	1	3	5	3	0	1	0	1	5	5	5	5	66
Ross' gull (*Rhodostethia rosea*)	5	5	3	5	3	3	3	3	1	3	5	5	0	1	0	1	3	1	3	3	56
Sabine's gull (*Xema sabini*)	3	3	3	5	1	3	3	3	1	3	1	3	0	1	1	1	3	3	3	0	44
Common tern (*Sterna hirundo*)																			1		1
Arctic tern (*S. paradisaea*)	1	1	1	3	1	3	3	3	1	3	1	1	0	1	1	1	3	1	3	0	32
Aleutian tern (*S. aleutica*)	5	3	3	5	3	3	3	3	1	3	1	1	0	1	1	1	5	5	5	1	53
Caspian tern (*Hydroprogne caspia*)																			1		1
Black tern (*Chlidonias niger*)																			1		1
Alcidae																					
Common murre (*Uria aalge*)	1	5	3	5	1	5	5	5	5	5	5	3	1	1	3	5	3	3	3	3	70
Thick-billed murre (*U. lomvia*)	1	5	3	5	1	5	5	5	5	5	5	3	1	1	3	5	3	3	3	3	70
Dovekie (*Plautus alle*)																		1			1
Black guillemot (*Cepphus grylle*)	1	5	3	5	3	5	5	5	5	3	5	5	1	1	1	5	3	3	3	3	70
Pigeon guillemot (*C. columba*)	5	5	3	5	3	5	5	5	5	3	5	5	1	1	3	5	5	5	5	3	82
Marbled murrelet (*Brachyramphus marmoratus*)	5	5	3	5	1	5	5	5	5	3	5	5	1	3	3	5	5	5	5	5	84
Kittlitz's murrelet (*B. brevirostris*)	5	5	5	5	1	5	5	5	5	5	5	5	1	3	3	5	5	5	5	5	88
Xantus' murrelet (*Endomychura hypoleuca*)																				1	1
Ancient murrelet (*Synthliboramphus antiquus*)	3	3	3	5	1	5	5	5	5	5	5	5	1	3	3	5	3	3	3	3	74
Cassin's auklet (*Ptychoramphus aleutica*)	5	3	5	5	1	5	5	5	5	5	5	5	1	3	3	5	5	5	5	3	84
Parakeet auklet (*Cyclorrhynchus psittacula*)	3	3	3	5	1	5	5	5	5	5	5	5	1	3	3	5	5	5	5	3	80
Crested auklet (*Aethia cristatella*)	3	3	3	5	1	5	5	5	5	5	5	5	1	3	1	5	5	3	5	3	76
Least auklet (*A. pusilla*)	3	3	3	5	1	5	5	5	5	5	5	5	1	3	3	5	5	5	5	3	80
Whiskered auklet (*A. pygmaea*)	5	5	5	5	1	5	5	5	5	5	5	5	1	3	3	5	5	5	5	5	88
Rhinoceros auklet (*Cerorhinca monocerata*)	3	3	3	5	1	5	5	5	5	5	5	5	1	3	3	5	3	3	3	3	74
Horned puffin (*Fratercula corniculata*)	3	5	3	5	1	5	5	5	5	3	5	5	1	3	1	5	3	3	3	3	72
Tufted puffin (*Lunda cirrhata*)	3	5	3	5	1	5	5	5	5	3	5	5	1	3	1	5	3	3	3	3	72
Alcedinidae																					
Belted kingfisher (*Megaceryle alcyon*)	1	1	3	1	1	1	1	5	1	0	1	3	0	3	1	1	1	1	1	1	28
Corvidae																					
Common raven (*Corvus corax*)	1	1	1	1	1	1	1	1	1	0	1	1	3	1	1	1	1	1	1	1	21
Northwestern crow (*C. caurinus*)	3	5	3	3	1	1	1	1	1	0	1	3	1	1	1	1	5	5	5	5	47

Table 2. *Criteria and points used in calculating Oil Vulnerability Index.*

	Point assignment		
	1	3	5
Range			
Breeding	Large	Medium	Small
Migration	Long	Medium	Short
Winter	Large	Medium	Small
Marine orientation	Coastal zone	Intertidal	Open water
Population			
Size	Large	Medium	Small
Productivity	Large	Medium	Small
Habits			
Roosting	Shore	Drift	Water
Foraging	Walking	Flying	Swimming
Escape	Leave area	Fly	Dive
Flocking	Small	Medium	Large
Nesting density	Low	Medium	High
Specialization	Low	Medium	High
Mortality			
Hunted by man	Low	Medium	High
Animal depredations	Low	Medium	High
Non-oil pollution	Low	Medium	High
History of oiling	Low	Medium	High
Exposure			
Spring	Low	Medium	High
Summer	Low	Medium	High
Fall	Low	Medium	High
Winter	Low	Medium	High

be needed, and where periodic project shutdown could be called for.

With these points in mind it is immediately obvious that Southeast Alaska (Table 4), which has only 9 high-score birds, offers far less potential for bird problems than does the Aleutian area (Table 5), which has 24 high-score species. The planning agency could make some immediate decisions on site priorities and research funding based on such information.

Discussion

We are convinced that the OVI principle expressed here will become a useful management tool with all sorts of possible applications. We recognize some difficulties with the present version, but believe it is timely to present the system so that a broader range of thought, improvements, and application can be applied to it.

Of prime importance is the system's simplicity. The use of four levels of value for each factor, instead of five or more, is an attempt to simplify. Ian McHarg (1969) has shown that extremely complex land-use values can be graphically compared and displayed by using three levels in a way that is useful to decision makers. The difficulty of using more levels of value was indicated by Sparrowe and Wight (1975) who used up to 10 levels, enormously complicating the problem of dealing with low-quality information, which is often all that is available. The use of scores of 0, 1, 3, 5 instead of 0, 1, 2, 3 for 20 factors enabled us to use the convenient 100 points instead of 60 points as the maximum potential total score for any species.

The 20 factors that were evaluated are admittedly arbitrary; with refinement and more detailed data they could be adjusted to show better separation between affected species. The decision to use 20 factors instead of more

Table 3. *Oil Vulnerability Index (OVI) for families of birds of the Northeast Pacific marine habitats, excluding rare and endangered species in the scoring.*

Family	Number of species	Total OVI	OVI per species	
			Average	Range
Loons—Gaviidae	4	219	55	47-65
Grebes—Podicipedidae	3	148	49	44-56
Albatrosses—Diomedeidae	2	102	51	50-52
Shearwaters—Procellaridae	4	208	52	47-57
Storm-petrels—Hydrobatidae	2	130	65	63-67
Cormorants—Phalacrocoracidae	4	235	59	52-63
Herons—Ardeidae	1	29	29	29
Waterfowl—Anatidae	33	1,765	53	32-78
Eagles and Hawks—Accipitridae	2	77	39	19-58
Ospreys—Pandionidae	1	37	37	37
Falcons—Falconidae	1	41	41	41
Cranes—Gruidae	1	24	24	24
Rails and Coots—Rallidae	1	33	33	33
Oystercatchers—Haematopodidae	1	65	65	65
Plovers—Charadriidae	7	287	41	26-57
Sandpipers—Scolopacidae	22	857	39	24-59
Phalaropes—Phalaropodidae	2	120	60	58-62
Jaegers and Skuas—Stercorariidae	3	123	41	39-43
Gulls and Terns—Laridae	16	730	46	32-66
Auks—Alcidae	15	1,164	78	70-88
Kingfishers—Alcedinidae	1	28	28	28
Crows—Corvidae	2	68	34	21-47
Total and Mean	128	6,490	51	19-88

or less again relates to simplicity. This appears to be the minimum number that will assure species separation and that can be neatly displayed.

The system will be much more useful when it is expanded to the subspecific level. Many Holarctic species are represented in the Northeast Pacific by a single race that would have a much higher OVI than the species as a whole. For example, the OVI for the Peale's peregrine falcon (*Falco peregrinus pealei*) confined to marine habitats within the Pacific region would be high; and the endangered Aleutian Canada goose (*Branta canadensis leucopareia*) would score 100 points instead of the 34 we show for Canada geese (*B. c.*). If Tables 4 and 5 showed subspecies, the differences in value would be more marked.

Tables 4 and 5 are for broad geographical areas. A comparison between smaller areas would probably show more dramatic differences.

Because the dearth of easily available, applicable information poses a problem in evaluating the various factors, our scoring was conservative. Experts on the various avian families can doubtless refine the scoring. If this system proves useful, investigators will begin to acquire the information needed for more precise evaluations. Ultimate perfection may never be achieved; however, as with the field guides, the fact of minor professional disagreement should not destroy the system's utility.

We believe rescoring of all birds on the basis of various projects should be avoided because a standard against which individual projects can be measured is needed. If everyone did their own scoring, there would be no standard, and projects evaluated by different investigators would not be comparable. If a species list for the project area and standard point scores are used, the level of involvement for many species and perhaps for most species will be properly identified. As with any system, there will be exceptions and the assessor will need to deal with these as appropriate. The result will still be to focus attention on those species

acific marine habi-

)VI per species	
verage	Range
55	47-65
49	44-56
51	50-52
52	47-57
65	63-67
59	52-63
29	29
53	32-78
39	19-58
37	37
11	41
24	24
13	33
15	65
1	26-57
9	24-59
0	58-62
1	39-43
3	32-66
3	70-88
3	28
1	21-47
	19-88

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Table 4. *Oil Vulnerability Index for 109 species of birds of Southeast Alaska* (Total Points—2,678).

OVI 1-20		OVI 21-40		OVI 41-60		OVI 61-80		OVI 81-100	
Marsh hawk	19	Great blue heron	29	Common loon	47	Pelagic cormorant	63	Pigeon guillemot	82
52 species, rare or occasional (one point each)	52	Canada goose	34	Arctic loon	58	Oldsquaw	66	Marbled murrelet	84
		White-fronted goose	36	Red-throated loon	49	White-winged scoter	72		
		Snow goose	32	Red-necked grebe	44	Surf scoter	72		
		Mallard	36	Horned grebe	48	Black oystercatcher	65		
		Pintail	36	Whistling swan	50	Northern phalarope	62		
		Green-winged teal	34	Trumpeter swan	63	Common murre	70		
		American wigeon	36	Greater scaup	52				
		Semipalmated plover	28	Lesser scaup	52				
		Killdeer	26	Common goldeneye	48				
		Common snipe	29	Barrow's goldeneye	56				
		Spotted sandpiper	24	Bufflehead	52				
		Greater yellowlegs	30	Harlequin duck	60				
		Lesser yellowlegs	30	Common merganser	56				
		Pectoral sandpiper	32	Red-breasted merganser	56				
		Least sandpiper	34	Bald eagle	58				
		Herring gull	38	Peregrine falcon	41				
		Bonaparte's gull	40	Black turnstone	57				
		Arctic tern	32	Rock sandpiper	59				
		Belted kingfisher	28	Dunlin	41				
		Common raven	21	Short-billed dowitcher	41				
				Western sandpiper	47				
				Glaucous-winged gull	56				
				Thayer's gull	42				
				Mew gull	44				
				Northwestern crow	47				
Totals	71		665		1,324		470		166

Table 5. *Oil Vulnerability Index for 123 species of birds of the Aleutian Islands* (Total Points—2,689).

OVI 1-20		OVI 21-40		OVI 41-60		OVI 61-80		OVI 81-100	
80 species, rare or occasional (one point each)	80	Canada goose	34	Fulmar	57	Fork-tailed storm-petrel	67	Pigeon guillemot	82
		Least sandpiper	34	Slender-billed shearwater	53	Leach's storm-petrel	63	Whiskered auklet	88
		Arctic tern	32	Greater scaup	52	Pelagic cormorant	63		
		Common raven	21	Common goldeneye	48	Red-faced cormorant	63		
				Bufflehead	52	Black brant	70		
				Harlequin duck	60	Emperor goose	70		
				Bald eagle	58	Oldsquaw	66		
				Peregrine falcon	41	Steller's eider	72		
				Ruddy turnstone	44	Common eider	68		
				Rock sandpiper	59	King eider	70		
				Western sandpiper	47	White-winged scoter	72		
				Red phalarope	58	Common scoter	72		
				Parasitic jaeger	43	Black oystercatcher	65		
				Glaucous-winged gull	56	Red-legged kittiwake	66		
				Black-legged kittiwake	49	Common murre	70		
						Thick-billed murre	70		
						Ancient murrelet	74		
						Parakeet auklet	80		
						Crested auklet	76		
						Least auklet	80		
						Horned puffin	72		
						Tufted puffin	72		
Totals	80		121		777		1,541		170

and impacting factors where it is most needed.

We have used our OVI system to show the vulnerability of birds to oil, but it seems likely that the vulnerability index could be applied on a much broader scale to help make decisions in other areas of human activity and resource development. The vulnerability index system could be applied to terrestrial as well as aquatic species by adding or subtracting impacting factors, as appropriate. Indexes relating the impact of man upon each North American species could have broad uses in the field of conservation. Population explosions, as well as declines, might be predictable. Human activity could be better adjusted to favor or depress wildlife populations, as appropriate.

We believe that this vulnerability index system has promise for aiding in the decision-making processes upon which future bird conservation will depend.

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