

FOIA MARKER

This is not a textual record. This is used as an administrative marker by the William J. Clinton Presidential Library Staff.

Collection/Record Group: Clinton Presidential Records
Subgroup/Office of Origin: Council on Environmental Quality
Series/Staff Member: Kathleen (Katie) McGinty
Subseries:

OA/ID Number: 2617
FolderID:

Folder Title:
Forest S.A.T. [Scientific Analysis Team] [2]

Stack:	Row:	Section:	Shelf:	Position:
S	61	5	7	3

BACKGROUND INFORMATION ON THE LATE SERAL-ASSOCIATED
VERTEBRATE SPECIES LONG LIST FOR THE SCIENTIFIC ANALYSIS TEAM

This list was developed for the three vertebrate groups- bird, mammal, and herptiles. It is referred to as the "long list". The objective was to include all old growth-mature (ie., late seral) associated species within the range of the Northern spotted owl. A species was put on the list if any of the references indicated use of late seral habitat or features (eg., downed logs, snags). The species may not be dependent or highly associated with mature or old growth cover but merely reported to use one of them.

The project was initiated to support the Scientific Analysis Team (SAT) in their effort to respond to the May 1992 ruling on the USFS Final Environmental Impact Statement (FEIS). The ruling requires the USFS address the effects of the owl management as identified in the FEIS on other old growth species. The long list provides the initial, all inclusive list of species that could be considered. It was later reduced to a short list of species that the SAT will actually analyze.

Nine references were used to identify potential candidates. These references are identified at the bottom of each list.

To clarify how the selection of species was done, the following about the references should be noted:

Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington (Brown-1985), coded as WOW. Any species was listed that was shown as a primary or secondary user of large sawtimber or old growth age classes in evergreen hardwood, conifer hardwood, mixed coniferous, temperate, high temperate, subalpine park or lodgepole pine forests. The later three types were included because they are considered dispersal habitat for the spotted owl.

California Department of Fish and Wildlife Habitat Relationship System (1989 version), code as CWH. Sorted for all species associated with mixed conifer or douglas fir, medium and large tree with moderate (40-59%) or dense (60-100%) crown closure.

Wildlife and Vegetation of Unmanaged Douglas-fir Forests (1991), coded as UF on list. A species was put on the list if identified as present (P), associated (+), or highly associated (*) in the mature or old-growth age classes (p.456-462).

USFWS Recovery Plan (draft 1992), coded as RP. The species identified on p.341, 343, and 346 were placed on the list.

For the remaining references, the narratives for each species were reviewed. If association with late seral habitat or feature (eg., downed logs, snags) were indicated, the species were placed on the list.

LITERATURE CITED -- APPENDIX 6-A

Anthony et al. 1982 (1992?)

Aubry (no dates given)

Beatty et al. 1991

Brown, E.R. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 1. Chapter narratives. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 332 p.

Bull 1990

Bull, E.L.; Henjum, M.G.; Rohweder, R.S. 1989. Reproduction and mortality of great gray owls in Oregon. Northwest Science. 63:38-43.

Carey 1992

Christy and West, in press

Goggans, R. 1986. Habitat use by flammulated owls in northeastern Oregon. Corvallis, OR: Oregon State University. 54 p. M.S. thesis.

Goggans et al. 1987

Gomez 1992

Hayward et al. 1990

Ingles 1967

Koehler, G.; Brittell, J. 1990. Managing spruce-fir habitat for lynx and showshoe hares. J. Forestry. 88(10):10-14.

Marcot, B.G. 1985. Habitat relationships of birds and young-growth Douglas-fir in northwestern California. Corvallis, OR: Oregon State University. 282 p. Ph.D. dissertation.

Marshall 1991

Raphael 1985

Raphael 1988

Reynolds references

Rosenburg and Anthony 1992

Ruggiero, L.F.; Aubry, K.B.; Carey, A.B.; Huff, M.H. 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report

PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 533 p.

Sakai and Noon 1991

Thomas, J.W.; Anderson, R.G.; Maser, C.; Bull, E.L. 1979. Snags. Pages 60-77 in: Thomas, J.W., ed. Wildlife habitats in managed forests the Blue Mountains of Oregon and Washington. Agriculture Handbook No. 553. Portland, OR: U.S. Department of Agriculture, Forest Service.

Appendix 6-B. Vascular plant species closely associated with old-growth
forests within the range of the Northern Spotted Owl
("short list")

APPENDIX B. VASCULAR PLANT SPECIES CLOSELY ASSOCIATED

WITH OLD-GROWTH FORESTS (with criteria)

SCIENTIFIC NAME	COMMON NAME	S T A T U S				CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
		FED	WA	OR	CA		
Achlys triphylla	Vanilla leaf					1	13,35,36
Adenocaulon bicolor	Trail plant					1	11,14,35,36
Adiantum pedatum	Western maidenhair fern					1	35,36
Allotropa virgata	Candy stick					1	13,35,36,37
Anemone deltoidea	Threeleaf anemone					1	35,36
Angelica tomentosa	California angelica					2	11,12
Apocynum pumilum	Dogbane					2	12, 14
Arceuthobium tsugense	Dwarf mistletoe					1	35,36
Arnica latifolia	Mountain arnica					1	35,36,37,38
Asarum caudatum	Wild ginger					1	11,12,35,38
Asarum hartwegii	Wild ginger					2	11, 12
Asarum wagneri	Green-flowered wild ginger				C1	4	
Bensoniella oregana	Bensoniella	C2		C1	R,1B	3	4,8,19
Berberis pumila	Dwarf mahonia					2	11,12
Boschniakia strobilacea	Ground cone					2	11
Botrychium ascendens					C	4	28
Botrychium crenulatum	Southwestern moonwort	C2			C	3	
Botrychium minganense	Victorin's grape fern		S		2	3	24,35,37
Botrychium montanum	Mountain grape-fern				2	3	35,37
Botrychium pumicola	Crater Lake (pumice) grapefern	C1		C1	1A	4	17, 18
Calypso bulbosa	Fairy-Slipper					1	11,13,14,35,36
Chamaecyparis lawsoniana	Port Orford cedar					1	35,38
Chamaecyparis nootkatensis	Alaska yellow cedar					1	35,36,38
Chimaphila menziesii	Pipsissewa					1	35,36
Chimaphilia umbellata	Common pipsissiwa					1	13,35,36,37
Cimicifuga elata	Tall bugbane		S	C		3	35,37
Clintonia uniflora	Queen's cup					1	2,12,35,36
Coptis asplenifolia	Spleenwort-leaved goldthread		S			2	16,25
Coptis laciniata	Goldthread					1	35,36,37
Corallorhiza maculata	Pacific coral root					1	35,36,37
Corallorhiza mertensiana	Western coral-root					1	35,36,37
Cupressus bakeri	Baker's cypress				2	3	19
Cypripedium fasciculatum	Clustered lady's slipper		T	C		4	11
Cypripedium montanum	Mountain lady's slipper					3	8,11,12
Dentaria californica	Toothwort					2	13
Disporum hookeri	Fairy bell					1	13
Dryopteris austriaca	Spreading wood-fern					1	35,36
Eburophyton austiniae	Phantom orchid					1	35,36,37
Erythronium montanum	Avalanche lily					1	35,36
Fritillaria gentneri	Gentner's mission-bells	C2		C		4	
Galium kamtschaticum	Boreal bedstraw		S			2	16
Gaultheria humifusa	Western wintergreen					1	35,36
Gaultheria ovatifolia	Oregon wintergreen					1	35,36
Goodyera oblongifolia	Rattlesnake plantain					1	35,36
Gymnocarpium dryopteris	Oak fern					1	35,36

Habenaria orbiculata	Large round-leaved rein-orchid		1	35,36
Habenaria saccata	Slender bog orchid		1	35,36
Habenaria unalascensis	Alaska rein-orchid		1	35,36
Haplopappus Whitneyi discoides	Whitney haplopappus	2	2	11, 12, 15
Hemitomes congestum	Gnome plant		2	13,15,35,37
Hieracium scouleri	Woolly-weed		2	39
Hypopitys monotropa	Pinesap		1	13,35,36,37
Lathyrus polyphyllus	Leafy peavine		1	35,38
Linnea borealis longifolia	(No common name)		2	13
Listera borealis	Northern twayblade	S	3	40
Listera caurina	Western twayblade		1	11, 12,35,36,37
Listera convallarioides	Broad-lipped twayblade		1	35,36
Listera cordata	Twayblade	4	1	35,36,37
Luzula hitchcockii	Smooth woodrush		1	35,36
Lysichitum americanum	Skunk cabbage		1	35,36
Melica subulata	Melic grass		1	35,38
Menziesia ferruginea	Fool's huckleberry		1	35,36
Mitella breweri	Brewer's mitrewort		1	35,36
Monotropa uniflora	Indian pipe		1	15,35,36,37
Oxalis oregana	Redwood sorrel		1	13
Phlox adsurgens	Woodland phlox		2	11,12,13
Picea breweriana	Brewer spruce		1	13,35,38
Pityopsis californica	Pinefoot		2	2,8,35,37
Platanthera obtusata	Small northern bog orchid	S	3	25
Pleuricospora fimbriolata	Fimbriate pinesap	S	3	8,13, 30,35,37
Poa laxiflora	Loose-flowered bluegrass	2	3	20, 31
Polystichum munitum var. imbricans	Imbricate sword-fern		2	11, 12
Pterospora andromedea	Woodland pinedrops		1	11, 12, 15, 35, 36
Pyrola asarifolia	Alpine pyrola		1	2,35,36,37,38
Pyrola chlorantha	Greenish wintergreen		1	35,36
Pyrola dentata	Toothleaf pyrola		1	35,38,39
Pyrola picta	White vein pyrola		1	35,36
Pyrola picta ssp. dentata	Nootka wintergreen		2	11, 12
Pyrola secunda	One-sided pyrola		1	35,36,37,38
Pyrola uniflora	Single flowered pyrola		1	35,36
Rubus lasiococcus	Dwarf bramble		1	35,38
Rubus nivalis	Snow bramble		1	35,36,37
Rubus pedatus	Fiveleaved bramble		1	35,36
Sarcodes sanguinea	Snow Plant		2	15
Satureja douglasii	Yerba buena		1	35,38
Selaginella oregana	Oregon selaginella		1	35,36
Silene nuda	Not available	2	4	17
Smilacina racemosa	Solomons seal		1	13,35,36
Smilacina stellata	Star-flowered solomon-plume		1	35,36
Streptopus amplexifolius	Clasping-leaved twisted-stalk		1	35,36,37
Streptopus roseus	Rosy twisted-stalk		1	35,36
Streptopus streptopoides	Twisted-stalk		1	35,36
Synthyris schizantha	Fringed synthyris		1	35,36
Taxus brevifolia	Pacific yew		1	2,35,36,37,38
Thuja plicata	Western red cedar		1	35,36,37
Tiarella trifoliata	Three-leaved foamflower		1	35,36,37,38
Tiarella unifoliata	Coolwort foamflower		1	35,38
Trillium ovatum	Wake-robin		1	13,35,36
Trillium ovatum ssp. oettingeri	Salmon Mtns. Wakerobin	4	1	11

Vaccinium alaskaense	Alaska huckleberry	1	35,36
Vaccinium membranaceum	Thin-leaved huckleberry	1	35,36,38
Vaccinium ovalifolium	Oval-leaf huckleberry	1	35,36
Vaccinium parvifolium	Red huckleberry	1	35,38
Vancouveria hexandra	Inside-out flower	1	11,12,13
Vancouveria planipetala	Inside-out flower	1	11,12,13
Vicia americana var. villosa	American vetch	1	35,38
Viola glabella	Pioneer violet	1	35,36
Viola orbiculata	Round-leaved violet	1	35,36
Viola renifolia	Kidney-leaved violet	4	16,33,34
Whipplea modesta	Yerba de Selva	1	13
Xerophyllum tenax	Beargrass	1	35,36,38

EX

Legal status codes: (to be added)

1 = number not used

2 = Ruggiero, L. F., L. L. C. Jones, and E. B. Aubry. 1991b. Plant and animal habitat associations in Douglas-fir forests of the Pacific Northwest: an overview. Pages 447-462 in Ruggiero et al., eds. Wildlife and vegetation of unmanaged Douglas-fir forests. USDA, Forest Service, Pacific Northwest Research Station, Portland, Oregon. Gen. Tech. Report PNW-GTR-285. 533p.

3 = number not used

4 = Bingham, personal communication, May 20, 1992.

5 = Topik, Regional Ecologist, personal communication, 1992.

6 = Six Rivers National Forest, "FWS Candidate or Sensitive Plant Species of the Six Rivers National Forest Known or Suspected to Occur in Habitat Conservation Areas", October 1992.

7 = Diversity Database California Department of Fish & Game, 1992.

8 = Lisa Hoover, Forest Botanist, Forest TE&S Plants Program, Six Rivers National Forest, 1992.

9 = Marla Knight, Forest Botanist, Forest TE&S Plants Program, Klamath National Forest, 1992.

10 = Dave Esle, Forest Botanist, Forest TE&S Plants Program, Mendocino National Forest, 1992.

11 = Julie Nelson, Forest Botanist, Forest TE&S Plants Program, Shasta-Trinity National Forest, 1992.

12 = Sheila Logan, Zone Ecologist, Ecological Classification Program Data, Shasta-Trinity National Forest, 1992.

13 = B. Bingham, 10/92 unpublished data, Old-growth program, USFS Pacific Southwest Research Station, Arcata, California.

14 = Vivian Long, Botanist, Shasta-Trinity National Forest, 1992.

15 = P.A. Munz and D.D. Keck. 1973. A California flora with supplement. UC Press, Berkeley and Los Angeles, California. 1681 pp.

16 = Hitchcock, C.L. and Cronquist. 1973. Flora of the Pacific Northwest, Univ. of Wash., Press, Seattle, WA.

17 = Carol Tyson, District Botanist, Winema National Forest, 1992.

18 = Cindi O'Neil, District Botanist, Deschutes National Forest, 1992.

- 19 = Linda Mullens, Botanist, Siskiyou National Forest, 1992.
- 20 = Larry Scofield, Botany Division of Resources, Salem BLO, Salem, OR., 1992.
- 21 = number not used
- 22 = Wayne Rolle, Botanist, Rogue River National Forest, 1992.
- 23 = Wagner, W.J. and L.P. Lord, 1956. The Morphological and Cytological Distinctness of Botrychium minganense and Botrychium lunaria in Michigan. Bull. of the Torrey Botanical Club. Vol 83 No. 4 pp. 261-280.
- 24 = Steve Rust, Botanist, Wenatchee National Forest, 1992.
- 25 = Laura Potash, Botanist, Mt Baker-Snoqualmie National Forest, 1992.
- 26 = Meinke, R.J. Threatened and Endangered Vascular Plants of Oregon: An Illustrated Guide, U.S. Fish and Wildlife Service, Portland, Oregon.
- 27 = Bierly, Kenneth F. and R.E. Stockhouse II., 1982. Coast Fawn Lilly (Erythronium revolutum) Sensitive Species Conservation Report. Prepared for USDA Forest Service, Siuslaw National Forest Contract # 400-0410-2-384.
- 28 = John Gamon, Botanist, Washington National Heritage Program, 1992.
- 29 = Moldenke, A. 1981. Endangered and Threatened Plant Status Report, U.S.D.A. Forest Service, Willamette National Forest, Eugene, Oregon.
- 30 = Species management guide for Pleuricospora fimbriolata. 1988. USDA Forest Service, Gifford Pinchot National Forest.
- 31 = Species Management Guide for Loose-flowered bluegrass Poa laxiflora. 1988. USDA Forest Service, Siuslaw National Forest.
- 32 = Linda Kunze, Wetlands Ecologist, Washington Natural Heritage Program, 1992.
- 33 = An Illustrated Guide to the Endangered, Threatened and Sensitive Vascular Plants of Washington. 1981, Washington Natural Heritage Program, Olympia, WA.
- 34 = Hulten, E. 1968. Flora of Alaska and Neighboring Territories Stanford Univ. Press. Stanford, California.
- 35 = R-6 Ecology Data Base Analysis (Robin Lesher). Oct - Nov 1992.
- 36 = Jan Henderson and Robin Lesher, Ecologists, Mt. Baker-Snoqualmie and Olympic National Forests, 1992.
- 37 = Cindy McCain, Ecologist and Jenny Dimling, Botanist, Willamette National Forest, 1992.

38 = Tom Atzet, Pat Martinez and Lisa McCrimmon, Ecologist, Rogue River and Siskiyou National Forests, 1992.

39 = Brad Smith, Ecologist, Wenatchee and Okanogan National Forests, 1992.

40= George Wooton, Botanist, Okanogan National Forest, 1992.

* **Additional sources/references:**

Spies, T.A. 1991. Plant Species Diversity and Occurrence in Young, Mature, and Old-Growth Douglas-fir Stands in Western Oregon and Washington. In: Wildlife and Vegetation of Unmanaged Douglas-fir Forests, PNW-GTR-285, pp. 111-121.

Oregon Natural Heritage Program. 1991. Rare, Threatened and Endangered Plants and Animals of Oregon. Portland, OR

Meinke, R.J. 1982. Threatened and Endangered Vascular Plants of Oregon, an Illustrated Guide.

Siddell, J.L. et al. 1979. Rare, Threatened and Endangered Vascular Plants in Oregon, an Interim Report. Natural Area Preserves Advisory Committee.

Eastman, D.C. 1990. Rare and Endangered Plants of Oregon. Beautiful America Publishing Co.

Appendix 6-C. Potential threatened and endangered fish species and stocks
within the range of the Northern Spotted Owl forests of
the Pacific Northwest ("short list")

Appendix C. Potential threatened and endangered fish species and stocks within the range of the Northern Spotted Owl forests of the Pacific Northwest.

<u>Forest</u>	<u>Species/Race</u>	<u>Stock</u>
<u>California</u>		
Mendocino	Chinook Fall	Lower Eel River
	Steelhead Trout Winter	Sacramento River
	Summer	Eel River
Six Rivers	Chinook Salmon Spring/ Summer	Klamath River Smith River
	Fall	Lower Klamath River Tributaries Smith River
	Coho Salmon	Klamath River
	Steelhead Trout Summer	Eel River Mad River Smith River Klamath River
	Coastal Cutthroat	California Coastal Streams
Shasta- Trinity	Chinook Spring/ Summer	Klamath River
	Steelhead Trout Winter	Sacramento River
	Summer	Klamath River
Klamath	Chinook Spring/ Summer	Klamath River
	Fall	Shasta River Scott River
	Coho Salmon	Klamath River

Appendix C. (Continued)

<u>Forest</u>	<u>Species/Race</u>	<u>Stock</u>
<u>Oregon</u>		
Mt. Hood	Steelhead Trout Summer	Klamath River
	Chinook Salmon Spring/ Summer	Sandy River Hood River
	Fall	Hood River
	Coho Salmon	Clackamas River Sandy River Hood River
	Steelhead Trout Winter	Lower Columbia River Tributaries above Bonneville Dam Clackamas River Hood River Fifteen Mile Creek
	Summer	Lower Columbia River Tributaries above Bonneville Dam Hood River
Willamette	Sea-run Cutthroat Trout	Hood River
	Chinook Spring/ Summer	Willamette River
Siuslaw	Steelhead Winter	Calapooia River
	Chinook Salmon Spring/ Summer	Alsea River Siletz River
	Fall	Yachats River Yaquina River

Appendix C. (Continued)

<u>Forest</u>	<u>Species/Race</u>	<u>Stock</u>
Umpqua	Coho Salmon	Siuslaw River Umpqua River Yachats River Alsea River Beaver Creek Siletz River Salmon River Nestucca River
	Chum Salmon	Umpqua River Alsea River Yaquina River Siletz River Nestucca River
	Steelhead Trout Winter	Siuslaw River Big Creek Tenmile Creek Yachats River Alsea River Yaquina River Siletz River Salmon River Nestucca River
	Summer	Siletz River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
	Chinook Salmon Spring/ Summer	South Umpqua
	Coho Salmon	Umpqua River
	Chum Salmon	Umpqua River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
	Chinook Salmon Spring/ Summer	Coquille River
Siskiyou	Fall	Winchuck River Pistol River Rogue River

Appendix C. (Continued)

<u>Forest</u>	<u>Species/Race</u>	<u>Stock</u>
	Coho Salmon	Winchuck River Chetco River Pistol River Rogue River Elk River Sixes River Coquille River
	Chum Salmon	Elk River Sixes River
	Steelhead Trout Winter	Illinois River
	Summer	Rogue River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Rogue River	Coho Salmon	Rogue River
<u>Washington</u>		
Mt. Baker-Snoqualmie	Chinook Salmon Spring/ Summer	White River Stillaguamish River North Fork Nooksack River South Fork Nooksack River
	Coho Salmon	Nooksack River
	Steelhead Trout Winter	Nooksack River
	Summer	Stillaguamish River Nooksack River
Olympic	Chinook Salmon Spring/ Summer	Skokomish River Dosewallips River Dungeness River Elwha River Wynoochee River
	Fall	Duckabush River Dosewallips River Dungeness River

Appendix C. (Continued)

<u>Forest</u>	<u>Species/Race</u>	<u>Stock</u>
	Coho Salmon	Lyre River Elwha River
	Chum Salmon	Hood Canal (early-timed) Elwha River
	Pink Salmon	Skokomish River Dungeness River Elwha River
	Steelhead Trout Winter	Skokomish River
	Sea-run Cutthroat Trout	Washington Coastal and Puget Sound Tributaries (except Grays Harbor and Hood Canal Tributaries) Grays Harbor and Hood Canal Tributaries
Gifford Pinchot	Steelhead Trout Winter	Lower Columbia River Tributaries above Bonneville Dam Toutle River Wind River
	Summer	Wind River
	Sea-run Cutthroat Trout	Toutle River Kalama River
Wenatchee	Sockeye Salmon	Wenatchee River
	Steelhead Trout Summer	Wenatchee River Entiat River
Okanogan	Chinook Salmon Spring/ Summer	Methow River Okanogan River
	Steelhead Trout Summer	Methow River Okanogan River

Appendix C. (Continued)

Non-Anadromous Fish Covered

<u>Forest</u>	<u>Species/Race</u>
Shasta-Trinity	Red-band Trout
Mt. Hood	Red-band Trout
Willamette	Bull Trout
	Oregon Chub
Umpqua	Oregon Chub
Rogue River	Bull Trout
Deschutes	Bull Trout
Winema	Bull Trout
Mt. Baker-Snoqualmie	Bull Trout
Olympic	Olympic Mudminnow
Gifford Pinchot	Bull Trout
Wenatchee	Bull Trout
Okanogan	Bull Trout

<u>Common Name</u>	<u>Scientific Name</u>
Chinook salmon	<u>Oncorhynchus tshawytscha</u>
Coho salmon	<u>O. kisutch</u>
Steelhead trout	<u>O. mykiss</u>
Sea-run cutthroat trout	<u>O. clarkii clarkii</u>
Sockeye salmon	<u>O. nerka</u>
Chum salmon	<u>O. keta</u>
Pink salmon	<u>O. gorbuscha</u>
Redband trout	<u>O. mykiss gibbsi</u>
Bull trout	<u>Salvelinus confluentus</u>
Oregon Chub	<u>Oregonichthys crameria</u>
Olympic mudminnow	<u>Novumbra hubbsi</u>

Appendix 6-D. Attributes of terrestrial vertebrates highly associated with
old-growth forests ("short list") (with references)

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

'Short List'

file 'ATTRIBS.WQ1'

Scientific Analysis Team

Dec. 1, 1992

P=Primary; S=Secondary

/ = most/less use; () = equal use; * = spec. hab. req.

young

Canopy: growth

<=25% w/ classic

legacies old growth

Species	Breeding, foraging, and resting habitat										Microhabitat				
	Successional stages					Old growth stand structural stages									
	Young		Mid	Late successional											
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree		

HERPS

Amphibians

Oregon Slender salamander	S	P/S	(PS)	(PS)	P/S		X	X		X			
Larch Mt. salamander			S	P	P				X				
Siskiyou Mt. salamander			P	P	P (assumed)				X				
Del Norte salamander			S/P	S/P	P/S	X			X				
Van Dyke's salamander			S	(PS)	P/S			X	X	X	X		
Dunn's salamander	S	S	S/P	(PS)	P		X	X	X	X	X		
Black salamander	(PS)	(PS)	P/S	(PS)	(PS)	X	X	X	X	X	X		
California slender salamander	S	S/P	(PS)	P/S	P/S		X	X	X	X	X		
Clouded salamander	P	P	(PS)	S	(PS)	X	X	X	X	X	X	X	X
Pacific giant salamander			(PS)	(PS)	P/S	X	X	X	X	X	X		
Cope's giant salamander	P*	P*	(PS)*	(PS)*	P*		X	X			X		
Olympic salamander			P/S	P/S	P				X				
Northwestern salamander	(PS)	(PS)	S	(PS)	P/S		X	X		X	X		
Shasta salamander				P	P	X		X	X	X			
Roughskin newt	(PS)	(PS)	(PS)	P/S	P/S		X	X		X	X		
Tailed frog	S	S	P/S	P/S	P/S		X	X	X	X			

16 amphibian species

Reptiles

* = special habitat features required

0 reptile species

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

'Short List'

Species	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatll. rating	Migratory or resident (m or r)	Strong riparian assoc.?
	Stand	Landscape	Range				

HERPS

Amphibians

Oregon Slender salamander	X			28	20	R	
Larch Mt. salamander	X			28	10	R	
Siskiyou Mt. salamander	X			28	16	R	
Del Norte salamander	X				16	R	
Van Dyke's salamander	X			28	18	R	X
Dunn's salamander	X			24	14	R	X
Black salamander	X				18	R	X
California slender salamander	X				26	R	
Clouded salamander	X			30	22	R	
Pacific giant salamander	X			29	17	R	X
Cope's giant salamander	X					R	X
Olympic salamander	X			28	13	R	X
Northwestern salamander	X			23	19	R	X
Shasta salamander	X					R	X
Roughskin newt	X			23	19	R	X
Tailed frog	X			24	14	R	X

16 amphibian species

Reptiles

0 reptile species

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

not
really
endemic
to the
range
of the
NSO

is
endemic
to the
range
of the
NSO

Species	Presence															Degree of endem
	By state			By physiographic province (from Draft Recovery Plan)												
				Washington				Oregon				California				
	WA	OR	CA	OLPE	WACA	WACAE	WA LowIn	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast		

HERPS

Amphibians

Oregon Slender salamander		X						X	X						X
Larch Mt. salamander	X	X			X			X	X						
Siskiyou Mt. salamander		X	X								X	X			
Del Norte salamander		X	X								X	X		X	X
Van Dyke's salamander	X			X	X	X	X							X	(x popn.)
Dunn's salamander	X	X	X				X	X	X	X	X			X	X
Black salamander		X	X								X	X	X	X	
California slender salamander		X	X								X			X	
Clouded salamander		X	X					X	X	X	X	X		X	
Pacific giant salamander	X	X	X		X	X	X	X	X	X	X	X	X	X	
Cope's giant salamander	X	X		X	X	X	X	X	X	X					X
Olympic salamander	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Northwestern salamander	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Shasta salamander			X										X		
Roughskin newt	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Tailed frog		X	X	X	X	X		X	X	X	X	X		X	

16 amphibian species

Reptiles

0 reptile species

** = If references noted that the species is susceptible to forest fragmentation or loss of old growth, then it is denoted here as a decreasing trend. Used only for herps.

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

qualit. rank:

S = scarce

everywhere

C = common

somewhere

very

tiny

range

**General
abundance**

ism

within

Population trend w/in NSO range

Species	Restricted	NSO range	Population trend w/in NSO range			References
			Increasing	Stable	Decreasing	

HERPS

Amphibians

Oregon Slender salamander		C			** X	2,3a,21-9
Larch Mt. salamander	X	S			** X	2,3a,21-9
Siskiyou Mt. salamander	X	C			** X	2,3a,21-2,21-9
Del Norte salamander		S			** X	2,21-2,21-9
Van Dyke's salamander		C			** X	2,3a,21-9
Dunn's salamander		C			** X	2,3a,21-9
Black salamander		C			** X	2,21-9
California slender salamander		C		X		2,21-9
Clouded salamander		C			** X	2,3a,14a,21-2,21-9
Pacific giant salamander		C?			** X	2,3a,21-2,21-9
Cope's giant salamander		S			** X	21-9
Olympic salamander		C			** X	2,3a,21-2,21-9
Northwestern salamander		C		X		2,3a,21-2,21-9
Shasta salamander	X	S			** X	21-2
Roughskin newt		C			** X	2,3a,3b,21-2,21-9
Tailed frog		S			** X	2,3a,21-2,21-9

16 amphibian species

Reptiles

0 reptile species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Comments
---------	----------

HERPS

Amphibians

Oregon Slender salamander	
Larch Mt. salamander	
Siskiyou Mt. salamander	
Del Norte salamander	
Van Dyke's salamander	Disjunct pops in w. WA and so. ID
Dunn's salamander	rocks, streams, waterfalls (Beatty and Blaustein 1992)
Black salamander	
California slender salamander	
Clouded salamander	
Pacific giant salamander	
Cope's giant salamander	
Olympic salamander	
Northwestern salamander	
Shasta salamander	uses limestone areas
Roughskin newt	OG associate in WA only (Ruggiero et al. 1991)
Tailed frog	

16 amphibian species

Reptiles

0 reptile species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

file 'ATTRIBS.WQ1'

Scientific Analysis Team

Dec. 1, 1992

P=Primary; S=Secondary

/=most/less use; ()=equal use; * =spec. hab. req.

young
Canopy: growth
<=25% w/ classic
legacies old growth

Species	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young	Mid	Late successional										
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree

BIRDS

Marbled murrelet			S	S	P			X					X
Barrow's goldeneye				P	P			X				X	
Bufflehead				P	P			X				X	
Wood duck				P	P			X		X		X	
Hooded merganser				P	P			X				X	
Common merganser				P	P			X				X	X
Harlequin duck			P	P	P								
Northern goshawk			S	P/S	P/S	X		X					X
Bald eagle	S			S	(PS)	X		X				X	X
Barred owl			S	(PS)	(PS)	X		X				X	
Northern pygmy-owl	S	S	S	P/S	P/S	X		X				X	
Northern spotted owl			S	S	P/S	X		X				X	X
Flammulated owl	P	P		P	P	X	X	X				X	
Great gray owl				P	P			X				X	X
Vaux's swift	P	P	S	S	P/S	X	X	X				X	X
Pileated woodpecker	S		S	S	P/S	X		X		X		X	X
Hairy woodpecker			S	S	P/S	X		X		X		X	
White-headed woodpecker			S	S	S/P			X				X	
Black-backed woodpecker			S	S/P	(PS)	X		X				X	
Three-toed woodpecker			S	(SP)	P/S	X		X		X		X	
Red-breasted sapsucker			S	S	S	X						X	

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatll. rating	Migratory or resident (m or r)	Strong riparian assoc.?
	Stand	Landscape	Range				

BIRDS

Marbled murrelet				24	6	R/D	X
Barrow's goldeneye				27	9	M/D/R	X
Bufflehead				27	9	M/R	X
Wood duck				27	25	M/R	X
Hooded merganser				27	12	D/M/R	X
Common merganser				27	9	D	X
Harlequin duck					6	M	X
Northern goshawk				26	19	E	
Bald eagle					19	D/R	X
Barred owl					21	R	
Northern pygmy-owl					36	R	
Northern spotted owl				26	12	R	
Flammulated owl						M	
Great gray owl						R	
Vaux's swift				27	34	M	
Pileated woodpecker				27	27	R	
Hairy woodpecker				22	22	R	
White-headed woodpecker					12	E/R	
Black-backed woodpecker					16	R	
Three-toed woodpecker					15	D/M	
Red-breasted sapsucker			X	26	26	D/R	

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

not

really

is

endemic

endemic

to the

to the

range

range

of the

of the

NSO

NSO

Species	Presence														Degree of endem	Broad	Local
	By state			By physiographic province (from Draft Recovery Plan)													
				Washington				Oregon				California					
WA	OR	CA	OLPE	WACA	WACAE	WA LowIn	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast				

BIRDS

Marbled murrelet	X	X	X	X	X	X	X			X	X	X		X	X	
Barrow's goldeneye	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Bufflehead	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Wood duck	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Hooded merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Common merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Harlequin duck	X	X	X	X	X	X	X	X	X	X	X			X	X	
Northern goshawk	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X'(OLY)
Bald eagle	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Barred owl	X	X		?	X	X	X	X	X						X	
Northern pygmy-owl		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Northern spotted owl	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flammulated owl	X	X	X			X		X	X		?	X	X	X	X	
Great gray owl		X						X	X		X				X	
Vaux's swift	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pileated woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Hairy woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
White-headed woodpecker	X	X	X			X		X	X		X	X	X	X	X	
Black-backed woodpecker	X	X	X		X	X		X	X		X	X	X		X	
Three-toed woodpecker	X	X			X			X							X	
Red-breasted sapsucker	X	X	X	X	X		X	X	X	X	X	X	X	X	X	

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

qualit. rank:

S = scarce

everywhere

C = common

somewhere

very

tiny

range

ism

**General
abundance**

within

NSO range

Population trend w/in NSO range

Increasing

Stable

Decreasing

References

BIRDS

Marbled murrelet		S			X	2,3,5,7,9,16a,16b,21-10,21-12
Barrow's goldeneye		S			X	2,3,5,16a,16b,21-8,21-12
Bufflehead		C			?	2,3,5,9,16a,16b,21-8,21-12
Wood duck		C			?	2,3,5,16a,16b,21-8,21-12
Hooded merganser		S				2,3,5,16a,16b,21-8,21-12
Common merganser		C				2,3,16a,16b,21-8,21-12
Harlequin duck		S			X	1,2,5,7,9,16a,16b,21-8,21-12
Northern goshawk		S			X	2,3,6,9,16a,16b,21-8,21-12
Bald eagle		S		?		1,2,7,16a,16b,21-1,21-6,21-8,21-12
Barred owl		C	X			2,16a,16b,12-8,21-12
Northern pygmy-owl		C				2,4,5,9,16a,16b,21-8,21-12
Northern spotted owl		S			X	2,3,5,16a,16b
Flammulated owl		C	Sharp - insufficient data			5,7,9,16a,16b,21-1,21-6,21-12
Great gray owl		S			X	5,9,16a,16b,21-1,21-12
Vaux's swift		C		X		2,3,4,7,16a,16b,13,21-6,21-8,21-12
Pileated woodpecker		S			X	2,3,4,5,7,9,14b,16a,16b,21-1,21-8,21-12
Hairy woodpecker		C			X	2,3,4,14b,16a,16b,21-1,21-8,21-12
White-headed woodpecker		S				2,7,9,16a,16b,21-1,21-8,21-12
Black-backed woodpecker		S			?	2,9,16a,16b,21-1,21-8,21-12
Three-toed woodpecker		S				2,9,16a,16b,21-8
Red-breasted sapsucker		C			X	1,2,3a,4,5,14b,16b,21-8,21-12

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Comments
---------	----------

BIRDS

Marbled murrelet	
Barrow's goldeneye	
Bufflehead	
Wood duck	
Hooded merganser	
Common merganser	
Harlequin duck	
Northern goshawk	
Bald eagle	
Barred owl	
Northern pygmy-owl	
Northern spotted owl	
Flammulated owl	
Great gray owl	
Vaux's swift	
Pileated woodpecker	
Hairy woodpecker	
White-headed woodpecker	
Black-backed woodpecker	
Three-toed woodpecker	
Red-breasted sapsucker	

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

file 'ATTRIBS.WQ1'

Scientific Analysis Team

Dec. 1, 1992

P=Primary; S=Secondary

/ = most/less use; () = equal use; * = spec. hab. req.

young
Canopy: growth
<=25% w/ classic
legacies old growth

Species	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional									
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Williamson's sapsucker			S	S	S	X						X	
Northern flicker	P	S	S	P/S	P/S	X		X		X		X	
Western flycatcher				S	P	X		X					
Hammond's flycatcher			S	(PS)	P			X					X
Chestnut-backed chickadee		S	P	P	P	X	X	X				X	
Brown creeper			S	P/S*	P/S*	X		X				X	
Red-breasted nuthatch			S	P	P	X		X		X		X	
White breasted nuthatch		S	S	P	P	X		X				X	X
Pygmy nuthatch			S	P	P	X		X				X	
Winter wren		P	S	P	P		X	X		X			
Golden-crowned kinglet		S	P/S	P/S	P	X							
Hermit thrush		P	(PS)	P	P/S*	X							
Varied thrush		P	S	P/S*	P/S*	X							
Hermit warbler			P/S	P/S	P/S	X							
Wilson's warbler		P	S	S/P	S/P								
Warbling vireo		S/P	S/P	S	P	X							
Red crossbill			S	P/S	P/S	X							

38 bird species

S* = secondary use in subalpine and lodgepole veg types only

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

Species	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatill. rating	Migratory or resident (m or r)	Strong riparian assoc.?
	Stand	Landscape	Range				
Williamson's sapsucker			X		15	D/M	
Northern flicker			X	24	33	R	
Western flycatcher			X		24	M	
Hammond's flycatcher			X	25	26	M	
Chestnut-backed chickadee			X	13	28	R	
Brown creeper			X	19	29	R	
Red-breasted nuthatch			X	19	24	R	
White breasted nuthatch			X		17	R	
Pygmy nuthatch			X		8	R	
Winter wren			X	14	27	D	
Golden-crowned kinglet			X	16	27	R	
Hermit thrush			X	23	30	D/E	
Varied thrush			X	20	28	D/E	
Hermit warbler			X	18	25	M	
Wilson's warbler			X	24	33	M	
Warbling vireo			X		26	M	
Red crossbill			X	23	23	R	

38 bird species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

not

really

is

endemic

endemic

to the

to the

range

range

of the

of the

NSO

NSO

Species	Presence															Range of the NSO	
	By state			By physiographic province (from Draft Recovery Plan)												Degree of endem	
				Washington				Oregon				California					
	WA	OR	CA	OLPE	WACA	WACAE	WA LowIn	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast	Broad	Local	
Williamson's sapsucker	X	X	X			X			X		X	X	X		X		
Northern flicker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Western flycatcher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Hammond's flycatcher	X	X	X	X	X	X	X	X	X			X	X		X		
Chestnut-backed chickadee	X	X	X	X	X	X	X	X		X	X	X	X	X	X		
Brown creeper	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Red-breasted nuthatch	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
White breasted nuthatch	X	X	X		X	X	X	X	X	X	X	X	X	X	X		
Pygmy nuthatch	X	X	X			X			X			X	X	X	X		
Winter wren	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Golden-crowned kinglet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Hermit thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Varied thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Hermit warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Wilson's warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Warbling vireo	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Red crossbill	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

36 bird species

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

qualit. rank

S = scarce

everywhere

C = common

somewhere

very

tiny

range

ism

**General
abundance**

within

Population trend w/in NSO range

Species	Restricted	NSO range	Population trend w/in NSO range			References
			Increasing	Stable	Decreasing	
Williamson's sapsucker		C		X		2,5,13,21-1,21-8,21-12
Northern flicker		C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Western flycatcher		C			X	1,2,4,5,14b,16b,21-8,21-12
Hammond's flycatcher		C			X	1,2,3a,4,5,13,14b,21-8,21-12
Chestnut-backed chickadee		C			X	1,2,3a,3b,4,5,14b,16a,21-8,21-12
Brown creeper		C			X	1,2,3a,4,5,14b,16a,21-8,21-12
Red-breasted nuthatch		C			X	1,2,3a,4,5,14b,16a,21-8,21-12
White breasted nuthatch		C			X	2,3b,4,5,14b,16a,21-8,21-12
Pygmy nuthatch		C				2,5,16a,21-8,21-12
Winter wren		C			X	1,2,3a,4,5,14b,16a,21-8,21-12
Golden-crowned kinglet		C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Hermit thrush		C			X	1,2,3a,4,5,13,14b,21-8,21-12
Varied thrush		C				2,3a,3b,4,5,16b,21-8,21-12
Hermit warbler		C			X	1,2,3a,4,5,14b,21-8,21-12
Wilson's warbler		C		X		1,2,3a,4,5,13,14a,21-8,21-12
Warbling vireo		C			X	1,2,4,5,13,14b,16a,21-8,21-12
Red crossbill		C			X	2,3a,3b,4,5,14b,16a,21-8,21-12

38 bird species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Comments
Williamson's sapsucker	
Northern flicker	assoc'd w/ open forests
Western flycatcher	incr. assoc'n with stand age (Marcot 1985)
Hammond's flycatcher	
Chestnut-backed chickadee	incr. assoc'n with stand age (Marcot 1985)
Brown creeper	
Red-breasted nuthatch	+/- equal use pole & med sawt stages (Marcot 1985)
White breasted nuthatch	
Pygmy nuthatch	
Winter wren	shifts to late shrub stage in fall (Marcot 1985)
Golden-crowned kinglet	
Hermit thrush	
Varied thrush	
Hermit warbler	
Wilson's warbler	
Warbling vireo	
Red crossbill	

38 bird species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

file 'ATTRIBS.WQ1'

Scientific Analysis Team

Dec. 1, 1992

P=Primary; S=Secondary

/ = most/less use; () = equal use; * = spec. hab. req.

young
Canopy: growth
<=25% w/ classic
legacies old growth

Breeding, foraging, and resting habitat														
Successional stages					Old growth stand structural stages					Microhabitat				
Young		Mid	Late successional											
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus					

MAMMALS

Marten			S	P	P			X		X		X	X
Fisher			S	P	P	X		X	X	X		X	X
Dusky-footed woodrat		P	P	P	P	X	X	X		X	X		
Northern flying squirrel			S	P	P	X		X		X		X	X
Douglas squirrel		P	P	P	P	X	X	X		X		X	X
Townsend's chipmunk	S	S	P/S	P/S	P/S		X	X	X	X			
Red tree vole (P.longicaudus)			(PS)	S/P	S/P	X	X	X			X		X
Red tree vole (P.pomo)											X		X
Western red-backed vole			P	P	P	X	X	X		X	X	X	
Southern red-backed vole			P	P	P		X	X	X	X			
Forest deer mouse				P	P			X		X			
Deer mouse	S	P	(PS)	S	S	X	X		X	X	X	X	
Pacific shrew	S	P/S	S	S	S	X	X			X	X		
Shrew-mole	S	S	S/P	P/S	S/P		X	X		X	X		
Big brown bat	P/S		S	S/P	P/S	X		X				X	
Silver-haired bat	P		P	S/P	P/S	X	X	X				X	
Hoary bat		P	P	P/S	P/S	X	X	X					X
Long-legged myotis	S	P	S/P	P/S	P/S		X	X				X	X
Yuma myotis	P	P	S/P	P	P		X	X				X	
California myotis	P/S	S/P	P	P/S	S/P	X	X	X		X		X	X
Keen's myotis	P/S	P/S	S	S/P	S/P		X	X				X	

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
	Stand	Landscape	Range				

MAMMALS

Marten			X	26	23	R	X
Fisher			X	26	23	R	
Dusky-footed woodrat		?			28		?(rec plan)
Northern flying squirrel		?		28	26	R	
Douglas squirrel		?		28	26	R	
Townsend's chipmunk	X				32	R	
Red tree vole (P.longicaudus)	X			28	14	R	
Red tree vole (P.pomo)	X						
Western red-backed vole	X			21	16	R	
Southern red-backed vole	X			18	19	R	
Forest deer mouse	X			27		R	
Deer mouse	X				42	R	
Pacific shrew	X			28	28	R	X
Shrew-mole	X			226	34	R	X
Big brown bat			?	25	33	R	X
Silver-haired bat			?	25	28	M/R	
Hoary bat			?		25	M	X
Long-legged myotis			?	25	32	M/R	X
Yuma myotis			?	25	30	?	Feeding
California myotis			?	25	27	R	
Keen's myotis		?		25	21	?	Feeding

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

not
really is
endemic endemic
to the to the
range range
of the of the
NSO NSO

Species	Presence														Degree of endem
	By state			By physiographic province (from Draft Recovery Plan)											
				Washington				Oregon				California			
	WA	OR	CA	OLPE	WACA	WACAE	WA LowIn	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast	

MAMMALS

Marten	X	X	X	X	X	X	X	X	X	X	X	X			X	
Fisher	X	X	X	X	X	X		X	X	X	X	X		X	X	
Dusky-footed woodrat		X	X					X		X	X	X	X	X	X	
Northern flying squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Douglas squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Townsend's chipmunk	X	X		X	X	X	X	X	X	X	X					X
Red tree vole (P.longicaudus)		X						X	X	X	X					X
Red tree vole (P.pomo)			X								X		X		X	
Western red-backed vole		X	X					X	X	X	X	X	X			X
Southern red-backed vole	X			X	X	X	X									X
Forest deer mouse	X			X	X	X	X								X	
Deer mouse	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pacific shrew		X	X							X	X	X	X	X	X	
Shrew-mole	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Big brown bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Silver-haired bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Hoary bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Long-legged myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Yuma myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
California myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Keen's myotis	X			X			X									X

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

qualit. rank:

S = scarce

everywhere

C = common

very

tiny

range

ism

somewhere

**General
abundance**

within

NSO range

Population trend w/in NSO range

Increasing

Stable

Decreasing

References

MAMMALS

Marten		S			X	1,2,3a,5,21-1,21-11
Fisher		S			X	2,3a,5,21-1,21-11
Dusky-footed woodrat		C				1,2,3a,5,21-3,21-4,21-11
Northern flying squirrel		C				1,2,3a,5,21-3,21-11
Douglas squirrel		C				2,3a,5,21-3,21-5,21-11
Townsend's chipmunk		C				1,2,3a,5,21-4,21-5,21-11
Red tree vole (P. longicaudus)		S				1,2,3a,5,11a,21-4
Red tree vole (P. pomo)						1,2,5,21-11
Western red-backed vole		C				1,2,3a,5,19,21-4,21-11
Southern red-backed vole						1,2,3a,5,21-5
Forest deer mouse						1,2,3a,3b,21-5
Deer mouse		C				2,3a,5,21-3,21-5,21-11
Pacific shrew		C				2,3a,5,21-4,21-11
Shrew-mole						1,2,3a,5,21-3,21-5,21-11
Big brown bat		C				2,3a,5,21-3,21-11
Silver-haired bat						2,5,11c,21-3,21-5,21-11
Hoary bat		C				2,5,21-3,21-11
Long-legged myotis		C				2,3a,5,21-3,21-5,21-11
Yuma myotis		C				2,3a,5,19,21-3,21-11
California myotis		C				1,2,3a,5,19,21-3,21-11
Keen's myotis						2,3a,21-5

Attributes of Terrestrial Vertebrates Highly Associated With Old-Growth Forests

Short List

Species	Comments
---------	----------

MAMMALS

Marten	
Fisher	
Dusky-footed woodrat	
Northern flying squirrel	
Douglas squirrel	
Townsend's chipmunk	
Red tree vole (P.longicaudus)	
Red tree vole (P.pomo)	little data available on habitat needs
Western red-backed vole	
Southern red-backed vole	
Forest deer mouse	
Deer mouse	
Pacific shrew	
Shrew-mole	
Big brown bat	
Silver-haired bat	
Hoary bat	
Long-legged myotis	
Yuma myotis	
California myotis	
Keen's myotis	

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

file 'ATTRIBS.WQ1'

Scientific Analysis Team

Dec. 1, 1992

P=Primary; S=Secondary

/=most/less use; ()=equal use; *=spec. hab. req.

young
Canopy: growth

<=25% w/ classic

legacies old growth

Species	Breeding, foraging, and resting habitat												
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional									
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Long-eared myotis		S	S/P	(PS)	P/S	Feeding	X	X				X	X
Fringed myotis	P	P	S	S	S	Feeding							
Little brown myotis	P	P	S/P	(PS)	P/S	X	X	X		X		X	
Lynx	P	P	P/S	P/S	P/S								
Elk	P/S	P/S	P/S	(PS)	(PS)	X							

26 mammal species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
	Stand	Landscape	Range				
	~ <60 ac	~ <1.5K ac	across provinces				
Long-eared myotis			?	25	30	R	Feeding
Fringed myotis			?	25	30	?	Feeding
Little brown myotis			?	25	34	R	Feeding
Lynx			X		21	R	
Elk			X	28	32	M	

26 mammal species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

not
really
endemic
to the
range
of the
NSO

Is
endemic
to the
range
of the
NSO

Species	Presence															Range of the NSO	Degree of endemism
	By state			By physiographic province (from Draft Recovery Plan)													
				Washington				Oregon				California					
	WA	OR	CA	OLPE	WACA	WACAE	WA LowIn	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast	Broad		
Long-eared myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Fringed myotis	X	X	X		X	X		X	X	X	X	X	X	X	X		
Little brown myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Lynx	X					X									X		
Elk	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

26 mammal species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

qualit. rank:

S = scarce

everywhere

C = common

somewhere

very

tiny

range

ism

**General
abundance**

within

NSO range

Population trend w/in NSO range

Increasing

Stable

Decreasing

References

Species	Restricted	General abundance within NSO range	Increasing	Stable	Decreasing	References
Long-eared myotis		S				2,3a,5,19,21-3,21-5,21-11
Fringed myotis		C				2,3a,5,21-3,21-5,21-11
Little brown myotis		C				2,3a,5,21-3,21-11
Lynx		S				2,20,21-6
Elk		C				2,3a,21-4,21-6,21-11

26 mammal species

**Attributes of
Terrestrial Vertebrates
Highly Associated
With Old-Growth Forests**

Short List

Species	Comments
Long-eared myotis	
Fringed myotis	
Little brown myotis	
Lynx	
Elk	

26 mammal species

SHORT LIST SPECIES ANNOTATIONS
TERRESTRIAL VERTEBRATES
Key to information on habitat attributes database
File: ATTRIBS.WQ1

BREEDING, RESTING, AND FORAGING HABITAT

Successional stages - Reference 2 was the primary source of information. Information on various species was also provided by 3b, 7, 8, 9, 11a, 11b, 11c and 20 (References begin on page 3).

Only vegetative communities used by northern spotted owls were assessed for use by each species for breeding, foraging, and resting. Those vegetative communities include: conifer hardwood, mixed conifer forest (SW Oregon), temperate conifer forest, high temperate coniferous forest, subalpine forest parks and lodgepole pine (Cascades). Subalpine forest and lodgepole are only considered as dispersal habitat for northern spotted owls. Within this section the following codes denote the combined use of vegetative communities and successional stages for breeding, resting, and foraging of species.

- P = Primary use of the successional stage for breeding, resting, and foraging by the species.
- S = Secondary use of the successional stage for breeding, resting, and foraging by the species.
- P/S = A combination of primary and secondary use of the successional stage, with disproportionately more primary use than secondary use by the species.
- S/P = A combination of primary and secondary use of the successional stage, with disproportionately more secondary use than primary use by the species.
- (PS) = A combination of primary and secondary use of the successional stage, with approximately half the use being primary and half being secondary by the species.

Young - Grass/forb = shrubs less than 40 percent crown cover and less than 5 feet tall; unit may range from mainly devoid of vegetation to dominance by herbaceous species (grasses and forbs); tree regeneration generally less than 5 feet tall and 40% crown cover.

Young - Shrub/sap = Shrubs greater than 40% crown canopy; average stand diameter greater than 1 inch dbh and tree canopy closure less than 60%; saplings are 1 to 4 inches dbh; poles 4 to 9 inches dbh.

Pole = Average stand diameters between 1 and 21 inches dbh and crown cover exceeding 60%.

Late successional - Mature = Stand with average diameters exceeding 21 inches in dbh; crown cover may be less than 100%, decay and decadence required for old-growth may be lacking, and dead and down material required by old growth is lacking.

Late successional - Old growth = Stands over 200 years old with at least two tree layers (overstory and understory), decay in living trees, snags, and down woody material. Some of the overstory layer may be composed of long-lived successional species (that is, Douglas-fir, western redcedar).

Stand structure - Reference 5 computer database was the primary source document for sparse structure types. Components and Classic OG were calculated from other attribute columns as explained below.

Sparse = An "X" denotes that the species use of habitat types with sparse canopy closure (less than 25%) was Moderate to High.

Components = primarily young growth with legacy components of older successional stages (ie. down logs, large trees and snags). An "X" in this column denotes the primary use of shrub/sap or pole successional stages and the use of at least one of the four microhabitat components listed below (down logs, duff/litter, large snags, large trees).

Classic OG = classic old-growth forest with multi-story and multi-species stands and a high decadence component. An "X" in this column denotes the primary use of old growth successional stage and the use of at least one of the four microhabitat components listed below.

Dispersal habitat = No primary information source documents were identified. This column is a description of habitat used by species for juvenile dispersal from natal areas, and adult dispersal from occupied habitats.

Microhabitat - References used were 2, 5, 7, 8, 9, and 19. Other sources included 11a, 11b, 11c and 20. An "X" denotes a close association (primary use) by the species with the specified habitat component (talus, down logs, duff/litter, large snags, and large trees).

Dispersal capability - No primary source documents were identified. An "X" in one of the following columns denotes the capability of juveniles and adults to disperse from natal and occupied habitat.

Stand = species will generally disperse in less than about a 60 acre area.

Landscape = species will generally disperse within approximately 60 acres to 5000 acres (subwatershed).

Range = species has the capability to disperse across physiographic province boundaries.

Lehmkuhl vulnerability rating - Reference 3a was used. The rating is a risk rating of local extinction of species. The higher the rating value the higher the risk of local extinction. Risk score = $3 * (\text{frequency} + \text{abundance}) + 2 * (\text{body size} + \text{vagility}) + \text{migratory status} + \text{variance in abundance}$. Scores for frequency, abundance and variation were assessed from data presented by Lehmkuhl and others. Total risk was calculated as the weighted sum.

Brown versatility rating - Reference 2. The rating is the sum of the number of plant communities and successional stages used for breeding plus the number of plants communities and successional stages used for feeding by a species. The higher the rating the higher the versatility of the species to use different vegetation communities.

Migratory Status - References 4, 11c, 16a, and 16b were used. Below are codes used to denote migratory status. More than one code was used for species which are known or suspected to have mixed migratory habits.

R = yearlong residents and nomads
M = latitudinal migrants including neotropical, lower-latitude nearctic, and high latitude nearctic migrants
D = displacement migrants
E = elevational migrants including seasonal downslope and upslope movements

Riparian Assoc. - References 1, 2, and 7 were used. An "X" denotes a strong riparian association for that species.

State and Physiographic province - Individual species range maps, which were derived from references 21-1 through 21-12 were used. An "X" denotes presence of the species in the state or province.

Degree of endemism - References 1, 3b, 16a, 16b, 16c and 18 along with individual species range maps, which were derived from reference 21-1 through 21-12, were used. An "X" in one of the following columns denotes the geographic range of the species as it relates to the range of the northern spotted owl.

Broad = geographic range extends beyond the range of the northern spotted owl (that is, not strictly endemic within the owl's range).

Local = geographic range does not extend beyond the range of the northern spotted owl but is fairly broad throughout at least one physiographic province therein.

Restricted = geographic range is restricted to a small portion of the Northern spotted owls' range, that is, occurs within a small portion of one or only a few physiographic provinces therein.

General abundance - References 13, 16a, 16b were used. Codes denote the general abundance of species throughout the range of the northern spotted owl.

S = scarce everywhere within the range of the northern spotted owl.
C = common in at least some areas within the range of the northern spotted owl.

Population trend - References 7, 9, 13, 14a, and 14b were used. Population trend of amphibians was based on trend in their preferred (macro)habitat.

References - References for information summarized in this datatable are coded as listed below.

- 1 USDI Fish and Wildlife Service. 1992. Recovery plan for the northern spotted owl-Draft. Portland, OR: U.S. Fish and Wildlife Service, Pacific Region. Appendix D. 329 p.
- 2 Brown, E.R., tech. ed. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Portland, OR: U.S. Forest Service, Pacific Northwest Region. Vol 2.
- 3a Lehmkuhl, J. F.; Ruggerio, L.F. 1991. Forest fragmentation in the Pacific Northwest and its potential effects on wildlife. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. p 45-46.
- 3b Ruggerio, L.F. 1991. Wildlife habitat relationships and viable populations. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. p 456-462.
- 4 Marcot, B.G. 1984. Habitat relationships of birds and young-growth Douglas-fir in northwestern California. p 161, 233-234. Ph.D. dissertation.
- 5 Zeiner, D.C.; Laudenslayer, Jr., W.R.; Mayer, K.E.; White, M., editors. 1988. California's Wildlife. Sacramento, CA: California Department of Forestry and Fire Protection. 166 p. 3 additional vol. 1 computer disk.

Vol I, Amphibians and reptiles. 1988.
Vol II, Birds. 1990.
Vol III, Mammals. 1990.
California Department of Fish and Game Wildlife Habitat Relationship System computer database; species sort by specified habitats
- 7 Rodrick, E.; Milner R., tech. editors. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife. 206 p.

- 8 Beatty, J.J., A.R. Blaustein, and R.M. Storm. 1992. A report to the northern spotted owl recovery team (subgroup addressing other species and older forest ecosystems, Robert G. Anthony, Chairperson): the biology of amphibians and reptiles. Corvallis, OR: Oregon State University. 86 p.
- 9 Marshall, D. 1992. Sensitive vertebrates of Oregon. Portland, OR: Oregon Department of Fish and Wildlife. 226 p.
- 11a Huff, M.H.; Holthausen, R.S.; Aubry, K.B. 1992. Habitat management for red tree voles in Douglas-fir forests. PNW-GTR-302. Portland, OR: USDA Forest Service, Pacific Northwest Region. 22 p.
- 11b Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. PNW-GTR-276. Olympia, WA: USDA Forest Service, Pacific Northwest Region. 53 p.
- 11c Christy, R.E.; West, S.D. n.d. [Draft]. Biology of bats in Douglas-fir forests. PNW-GTR-XXX. Portland, OR: USDA Forest Service, Pacific Northwest Region. 64 p.
- 13 Sharp, B.E. 1992. Neotropical migrants on National Forest in the Pacific Northwest: a compilation of existing information. Portland, OR: Ecological Perspectives, 2234 NE 9th Ave. 847 p.
- 14a Raphael, M.G. 1988. Long-term trends in amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. Management of Amphibians, Reptiles, and Small Mammals in North America: Proceedings of the Symposium; 1988 July 19-21; Flagstaff, AZ. GTR-RM-166. Ft. Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p 23-31.
- 14b Raphael, M.G.; Rosenberg, K.V.; Marcot, B.G. 1988. Large-scale changes in bird populations of Douglas-fir forests, northwestern California. In: Bird Conservation; Jackson, J.A. Editor. Madison, WI: University of Wisconsin Press, Ltd. p 63-83.
- 16a Robbins, C.S.; Bertel, B.; Zim, H.S. 1966. A guide to field identification: Birds of North America. Racine, WI: Golden Press New York. 344 p.
- 16b National Geographic Society. 1983. Field guide to the birds of North America. Washington, D.C.: National Geographic Society. 465 p.
- 16c Ehrlich, P.R.; Dobkin, D.S.; Wheye, D. 1988. The birder's handbook; A field guide to the natural history of North America birds. New York, NY: Simon and Schuster, Fireside. 814 p.
- 18 Ingles, L.G. 1976. Mammals of the Pacific states: California, Oregon, Washington. Stanford, CA: Stanford University Press. 520 p.

- 19 Verner, J.; Boss, A.S. tech. coordinators. 1980. California wildlife and their habitats: western Sierra Nevada. GTR-PSW-37. Berkeley, CA: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. 443 p.
- 20 Butts, T.W. 1992. Lynx (*Felix lynx*) biology and management. A literature review and annotated bibliography. Missoula, MT: USDA Forest Service, Northern Region. 268 p.

The following references were used to develop the individual species range maps:

- 21-1 Marshall, David B. 1992. Threatened and sensitive wildlife of Oregon's forests and woodlands. Audubon Society of Portland, Portland, Oregon. 66 p.
- 21-2 Zeiner, David C., William P. Laudenslayer, Jr., and Kenneth E. Mayer, compiling editors. 1988. California's wildlife. Vol. I - Amphibians and reptiles. California Dept. Fish and Game, Sacramento. 272 p.
- 21-3 Ingles, Lloyd G. 1965. Mammals of the Pacific States. California, Oregon, and Washington. Stanford University Press, Stanford, California. 506 p.
- 21-4 Maser, Chris, Bruce R. Mate, Jerry F. Franklin, and C. T. Dyrness. 1981. Natural history of Oregon Coast mammals. USDA Forest Service, Gen. Tech. Rpt. PNW-133. Portland, Oregon. 496 p.
- 21-5 Dalquest, Walter W. 1948. Mammals of Washington. Vol. 2. University of Kansas, Lawrence. 144 p.
- 21-6 Rodrick, Elizabeth, and Ruth Milner, tech. eds. 1991. Management recommendations for Washington's priority habitats and species. Washington Dept. Wildlife, Olympia, Washington. 189 p.
- 21-7 Hall, E. Raymond. 19xx. The mammals of North America. Vol. II. Second Edition. John Wiley & Sons, N.Y. 1271 p.
- 21-8 Peterson, Roger Tory. 1990. A field guide to western birds. Third edition. Houghton Mifflin Co., Boston Massachusetts. 432 p.
- 21-9 Leonard, William, Herbert Brown, Lawrence Jones, Kelly McAllister, and Robert Storm. [In press] Amphibians of Washington and Oregon. Audubon Society, Seattle, Washington. 30 p.
- 21-10 USDI Fish and Wildlife Service. Data via Oregon State Center for GIS.
- 21-11 Zeiner, David C., William F. Laudenslayer, Jr., Kenneth E. Mayer, and Marshall White, compiling editors. 1990. California's wildlife. Vol.

III - Mammals. California Department of Fish and Game, Sacramento. 407 p.

21-12 Zeiner, David C., William F. Laudenslayer, Jr., Kenneth E. Mayer, and Marshall White, compiling editors. 1990. California's wildlife. Vol. II - Birds. California Department of Fish and Game, Sacramento. 731 p.

Appendix 6-E. List of viability expert panel participants

Appendix 6-E. List of viability expert panel participants.

Non-Vascular Plants

Robin Leshner, USDA Forest Service (panel leader)
Joe Amariti, Department of Biology, University of Washington
John Christy, Oregon Natural Heritage Program
William Denison, Department of Botany and Plant Pathology,
Oregon State University
Dan Norris, Department of Botany and Plant Pathology, Oregon State University

Vascular Plants

Joan Ziegltrum, USDA Forest Service (panel leader)
Kenneth Berg, California Dept. of Fish and Game
Bruce Bingham, USDA Forest Service
Rex Crawford, Washington Natural Heritage Program
Terry Lillybridge, USDA Forest Service
Lisa McCrimmon, USDA Forest Service
David Peter, USDA Forest Service

Invertebrates

Handled through review contracts with:
David Olson, The Xerces Society
Ingrith Deyrup-Olsen, Department of Zoology, University of Washington

Fish

Gordon Reeves, USDA Forest Service
James Sedell, USDA Forest Service

Amphibians and Reptiles

Martin Raphael, USDA Forest Service (panel leader)
Keith Aubry, USDA Forest Service
Andy Blaustien, Department of Zoology, Oregon State University
John Brode, Inland Fisheries Division, California Department of Fish and Game
Bruce Bury, National Ecology Research Center, USDI Fish and Wildlife Service
Steven Corn, National Ecology Research Center, USDI Fish and Wildlife Service
Larry Jones, USDA Forest Service
Hartwell Welsh, USDA Forest Service

Birds

Bruce Marcot, USDA Forest Service (panel leader)
Andrew Hanson, Forest Sciences Department, Oregon State University
Mark Huff, USDA Forest Service
David Manuwal, College of Forest Resources, University of Washington
David Marshall, Consultant

Kevin McGarigal, Forestry Sciences Department, Oregon State University
Kim Nelson, Department of Fish and Wildlife, Oregon State University

Mammals

Robert Anthony, Department of Fish and Wildlife, Oregon State
University (panel leader)
Andrew Carey, USDA Forest Service
Steve Cross, Southern Oregon State College
Fred Gilbert, British Columbia
James Hallot, Department of Zoology, Washington State University
Chris McGuire, Huxley College, Western Washington University
Cindy Zabel, USDA Forest Service

Appendix 6-F. Examples of invertebrate species endemic to old-growth
forests (with figure)

**Examples of Invertebrate
Species Endemic to
Old-Growth Forests**

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
			FWS	Ols	

Phylum Arthropoda

Class Diplopoda (millipedes)

Order Chordeumatida

Family Caseyidae

<i>Caseya benedictae</i>	1				1
<i>Caseya briophila</i>	1				1
<i>Caseya bucketti</i>	1				1
<i>Caseya longiloba</i>	1				1
<i>Caseya megasoma</i>	1				1
<i>Caseya megasoma</i>	1				1
<i>Caseya shastaensis</i>	1				1
<i>Harpaphe haydeniana</i>	1			1	
<i>Metopiona sheari</i>	1				1
<i>Ochrogramma heterogona</i>	1				1
<i>Ochrogramma formulosa</i>	1				1
<i>Ochrogramma haigi</i>	1				1
<i>Opiona bifurcata</i>	1				1
<i>Opiona casualis</i>	1				1
<i>Opiona communis angusta</i>	1				1
<i>Opiona confusa</i>	1				1
<i>Opiona distincta</i>	1				1
<i>Opiona exigua</i>	1				1
<i>Opiona facetia</i>	1				1
<i>Opiona fisheri</i>	1				1
<i>Opiona goedeni</i>	1				1
<i>Opiona scytonotoides</i>	1				1
<i>Opiona siliquae</i>	1				1
<i>Tuhaphe levii</i>	1				1

TOTAL DIPLOPODA:	24	0
-------------------------	-----------	----------

**Examples of Invertebrate
Species Endemic to
Old-Growth Forests**

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
			FWS	Ols	

Class Arachnida

Order Araneida (spiders)

Family Agelenidae

<i>Cybaeina minuta</i>	1				1
------------------------	---	--	--	--	---

Order Phalangida (harvestman)

<i>Cryptomaster leviathan</i>	1				1
<i>Isolachus spinosus</i>	1				1
<i>Pentanychus hamatus</i>	1				1
<i>Pentanychus clavatus</i>	1				1
<i>Pentanychus bilobatus</i>	1				1
<i>Pentanychus flavescens</i>	1				1
<i>Pentanychus pacificus</i>	1				1

TOTAL ARACHNIDA:	8	0
-------------------------	---	---

Examples of Invertebrate Species Endemic to Old-Growth Forests

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
			FWS	Ols	

Class Insecta (Insects)

Order Orthoptera

<i>Boonacris alticola</i>	1			1	
<i>Pristoceuthophilus celatus</i>	1			1	
<i>Pristoceuthophilus cercalis</i>	1			1	
<i>Pristoceuthophilus sargentae</i>	1			1	
<i>Tropidischia xanthostoma</i>	1			1	

Order Hemiptera

<i>Boreostolis americanus</i>	1			1	
<i>Plinthius longisetosus</i>	1			1	
<i>Thylochromus nitidulus</i>	1			1	
<i>Eurychloptera sp.</i>	1			1	
<i>Phytocoris nobilis</i>	1			1	
<i>Pithanus maerkelii</i>	1			1	
<i>Polymerus castellaeni</i>	1			1	
<i>Vanduzeeia borealis</i>	1			1	
<i>Acalypta lillianis</i>	1			1	
<i>Acalypta saundersi</i>	1			1	
<i>Derephysia foliacea</i>	1			1	

Order Coleoptera

<i>Pterecus humboldti</i>	1				1
<i>Cychrus tuberculatus</i>	1			1	
<i>Metrius contractus</i>	1			1	
<i>Promecognathus laevis</i>	1			1	
<i>Zacotus mathewsii</i>	1			1	
<i>Omus dejeani</i>	1			1	
<i>Lobosoma horridum</i>	1			1	
<i>Acneus beeri</i>		1	C2	1	
<i>Acneus burnelli</i>			C2	1	
<i>Cicindela columbica</i>		1		1	
<i>Pterostichus rothi</i>	1			1	

Order Plecoptera

<i>Nemoura wahkeena</i>		1	C2	1	
<i>Solperia tenderi</i>		1	C2	1	

Order Trichoptera

<i>Eobrachycentrus gelidae</i>		1	C2	1	
<i>Agapetus denningi</i>		1	C2	1	
<i>Homoplecta schuhi</i>		1	C2	1	
<i>Ochrotrichia alsea</i>		1	C2	1	
<i>Lepidostoma goedeni</i>		1	C2	1	
<i>Apatania tavaia</i>		1	C2	1	
<i>Farula davisii</i>		1	C2	1	
<i>Farula jewetti</i>		1	C2	1	

**Examples of Invertebrate
Species Endemic to
Old-Growth Forests**

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
			FWS	Ols	

<i>Farula reaperi</i>		1	C2	1	
<i>Limnephilus alconura</i>		1	C2	1	
<i>Limnephilus atereus</i>		1	C2	1	
<i>Neothremma andersoni</i>		1	C2	1	
<i>Oligophlebodes mostbento</i>		1	C2	1	
<i>Philocasca oron</i>		1	C2	1	
<i>Dolophilodes oregona</i>		1	C2	1	
<i>Tinodes siskyou</i>		1	C2	1	
<i>Rhyacophila ambilis</i>		1	C2	1	
<i>Rhyacophila colonus</i>		1	C2	1	
<i>Rhyacophila fenderi</i>		1	C2	1	
<i>Rhyacophila haddocki</i>		1	C2	1	
<i>Rhyacophila lineata</i>		1	C2	1	
<i>Rhyacophila mosana</i>		1	C2	1	
<i>Rhyacophila unipunctata</i>		1	C2	1	
<i>Desmona bethula</i>		1	C2	1	
<i>Cryptochia shasta</i>		1	C2	1	
<i>Goeracea oregona</i>		1	C1	1	
<i>Neothremma genella</i>		1	C2	1	
<i>Neothremma siskyou</i>		1	C2	1	
<i>Ochrotrichia vertreesi</i>		1	C2	1	
<i>Abellan hydropsycha</i>		1	C2	1	

TOTAL INSECTA:	24	34
----------------	----	----

**Examples of Invertebrate
Species Endemic to
Old-Growth Forests**

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
			FWS	Ols	

Phylum Mollusca

<i>Fluminicola columbiana</i>		1	C2	1		Columbia pebblesnail
<i>Fisherola nuttalli nuttalli</i>			C3	1		Shortface lanx
<i>Monadenia fidelis minor</i>			C2	1		Dalles sideband
<i>Monadenia troglodytes chaceana</i>	1	1	C2	1		No common name
<i>Monadenia troglodytes troglodytes</i>	1	1	C2	1		Shasta sideband
<i>Monadenia troglodytes wintu</i>	1	1	C2	1		Wintu sideband
<i>Monadenia fidelis pronotis</i>		1	C2	1		Rocky coast sideband
<i>Monadenia setosa</i>	1	1	C2	1		Trinity bristlesnail
<i>Vespericola karokorum</i>	1	1	C1	1		Karok hesperian
<i>Juga hemphilli hemphilli</i>	1	1		1		Barren juga
<i>Juga hemphilli dallesensis</i>	1	1		1		Dalles juga
<i>Juga hemphilli subsp.</i>	1	1		1		No common name
<i>Juga (J.) n. sp. 1</i>	1	1		1		Brown juga
<i>Juga (J.) n. sp. 3</i>	1	1		1		Tall juga
<i>Juga (O.) n. sp. 1</i>		1		1		No common name
<i>Juga (O.) n. sp. 2</i>		1		1		No common name
<i>Juga (C.) actifilosa</i>	1	1		1		Scalloped juga
<i>Juga (C.) occata</i>		1		1		Topaz juga
<i>Amnicola (L.) n. sp.</i>	1	1		1		No common name
<i>Vorticifex neritoides</i>				1		Nerite rams-horn
<i>Physella columbiana</i>				1		Rotund physa
<i>Fluminicola seminalis</i>	1	1		1		Vagrant pebblesnail
<i>Lanx alta</i>	1			1		Highcap lanx
<i>Lanx patelloides</i>				1		Kneecap lanx
<i>Helisoma newberryi newberryi</i>		1		1		Great Basin rams-horn
<i>Vespericola columbiana columbiana</i>				1		Columbia hesperian
<i>Hemphillia malonei</i>	1	1		1		Malone jumping-slug
<i>Hemphillia pantherina</i>	1	1		1		Panther jumping-slug
<i>Hemphillia glandulosa glandulosa</i>	1	1		1		Warty jumping-slug
<i>Hemphillia barringtoni</i>	1	1		1		Burrington jumping-slug
<i>Prophysaon coeruleum</i>	1	1		1		Blue-gray tail-dropper
<i>Prophysaon dubium</i>	1	1		1		Papillose tail-dropper
<i>Monodenia fidelis columbiana</i>	1	1		1		Columbia sideband
<i>Monadenia fidelis beryllica</i>	1	1		1		Green sideband
<i>Monadenia fidelis celeuthia</i>	1	1		1		Traveling sideband
<i>Monadenia fidelis ochromphalous</i>	1	1		1		Yellow-base sideband
<i>Monadenia fidelis leonina</i>	1	1		1		Tawny sideband
<i>Monadenia fidelis klamathica</i>	1	1		1		No common name
<i>Monadenia churchi</i>	1	1		1		Klamath sideband
<i>Trilobopsis roperi</i>	1	1		1		Shasta chaparral
<i>Trilobasis tehamana</i>	1	1		1		Tehama chaparral

**Examples of Invertebrate
Species Endemic to
Old-Growth Forests**

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

	Old forest assoc.	Ripar. assoc.	Fed. status	Reference		Common name
				FWS	Ols	
<i>Vespericola shasta</i>	1	1		1		Shasta hesperian
<i>Vespericola sierrana</i>	1	1		1		Siskyou hesperian
<i>Vespericola megasoma euthales</i>	1	1		1		Large hesperian
<i>Megomphix hemphilli</i>	1	1		1		Oregon megomphix
<i>Anodonta wahlametensis</i>				1		Willamette floater
<i>Juga (Oreobasis) chacei</i>	1	1		1		No common name
<i>Juga (Oreobasis) orickensis</i>	1	1		1		No common name
<i>Lanx subrotundata</i>	1			1		Rotund lanx
<i>Monadenia callipeplus</i>	1	1		1		No common name
<i>Monadenia cristulata</i>	1	?		1		No common name
<i>Monadenia fidelis salmonensis</i>	1	1		1		No common name
<i>Monadenia fidelis scottiana</i>	1	?		1		No common name
<i>Monadenia rotifera</i>	1	?		1		No common name
<i>Haplotrema voyanum</i>	1	?		1		Hooded lancetooth
<i>Helminthoglypta hertleini</i>		1		1		Oregon shoulderband
<i>Deroceras hesperium</i>	1	1		1		Evening fieldslug
<i>Anodonta californiensis</i>		1	C2	1		California floater

TOTAL MOLLUSCA:	43	45
------------------------	-----------	-----------

TOTALS BY CLASS AND HABITAT

DIPLOPODA	24	0
ARACHNIDA	8	0
INSECTA	24	34
MOLLUSCA	43	45

GRAND TOTAL	99	79
-------------	----	----

TOTALS BY CLASS:

ARTHROPODS	91
MOLLUSCS	58
ALL	149

Examples of Invertebrate Species Endemic to Old-Growth Forests

file 'INVERTS.WQ1'

Scientific Analysis Team

4 Dec 1992

Old forest assoc.	Ripar. assoc.	Fed. status	Reference		
			FWS	Ols	Common name

a Federal Status: E: endangered; T: threatened; C: candidate.

References:

FWS = Draft Recovery Plan for the Northern Spotted Owl,

USDI Fish and Wildlife Service, 1992

Ols = Olson, David M. 1992. The northern spotted owl conservation strategy: implications for Pacific Northwest forest invertebrates and associated ecosystem processes. Final Contract Report Prepared for the Northern Spotted Owl EIS Team, USDA Forest Service. The Xerces Society, Portland, Oregon. 51 pp. + map. (From Table 1)

From Table 1, Olson 1992:

"This list is not exhaustive; invertebrate distributions and diversity are not well known in the Pacific Northwest and not all available published species accounts were reviewed, nor all appropriate specialists interviewed. Only four taxonomic revisions were examined for this list, and only six of the roughly fifty or so specialists familiar with the regional fauna were interviewed. This list is intended to provide examples to clarify taxonomic and ecological trends, and should be viewed as a tool for direction, not as a catalog of all relevant species. Some species reviewed possessing relatively limited distributions across several counties were arbitrarily excluded to focus on species with extremely narrow known ranges. All of the species are understory specialists and many of them are wingless or flightless." (p. 43)

Appendix 6-G. Viability ratings of fish stocks at risk, under the five
FEIS alternatives

Appendix 6-G. Viability ratings of fish stocks at risk, under the five FEIS alternatives. A seven-class rating scheme for viability was used (after Johnson et al. 1991).

Province	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Olympic	VL 1,4,5	M 3,4,5	MH 3,4,5	MH 3,4,5	VL 1,4,5
WA Cascades	L 1,4,5	ML 2,4,5	ML 2,4,5	M 3,4,5	VL 1,4,5
OR Coast Range	VL 1,4,5	L 1,4,5	ML 2,4,5	M 3,4,5	VL 1,4,5
OR Cascades	VL 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	VL 1,4,5
Klamath	VL 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	VL 1,4,5

- 1 - Approximately $\leq 25\%$ area of key watersheds within alternative
- 2 - Approximately 26-50% area of key watersheds within alternative
- 3 - Approximately $> 50\%$ area of key watersheds within alternative
- 4 - Has no watershed restoration program
- 5 - Lacks adequate riparian management area standards

Viability ratings codes:

- VH = very high
- H = high
- MH = medium high
- M = medium
- ML = medium low
- L = low
- VL = very low

These ratings were as defined by: Johnson, K.N.; Franklin, J.F.; Thomas, J.W.; Gordon, J. 1991. Alternatives for management of late successional forests of the Pacific Northwest. Scientific Panel on Late Successional Forest Ecosystems. A report to the Agriculture and Merchant and Marine Fisheries Committees of the U.S. House of Representatives. Washington, D.C.

Appendix 6-H. species with viability risk, all taxonomic classes

Species with Viability Risk

All taxonomic classes

file 'splist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Non-vascular Plants

1. Live wood

Lichens

<i>Alectoria sarmentosa</i>	1				1					1
<i>Bryoria capillaris</i>	1				1					1
<i>Bryoria tortuosa</i>	1				1					1
<i>Calicium abietinum</i>					1					
<i>Calicium adaequatum</i>					1					
<i>Calicium adspersum</i>					1					
<i>Calicium glaucellum</i>					1					
<i>Calicium viride</i>					1					
<i>Chaenotheca chrysocephala</i>					1					
<i>Chaenotheca ferruginea</i>					1					
<i>Chaenotheca subroscida</i>					1					
<i>Hypnum circinale</i>					1					
<i>Lobaria hallii</i>	1				1					1
<i>Lobaria linita</i>	1				1					1
<i>Lobaria oregana</i>	1				1					1
<i>Lobaria pulmonaria</i>	1				1					1
<i>Microcalicium arenarium</i>					1					
<i>Nephroma antiquorum</i>	1				1					1
<i>Nephroma isidiosum</i>	1				1					1
<i>Nephroma occultum</i>	1				1					1
<i>Pseudocyphellaria anomala</i>	1				1					1
<i>Pseudocyphellaria anthraspis</i>	1				1					1
<i>Pseudocyphellaria aurata</i>	1				1					1
<i>Pseudocyphellaria croccata</i>	1				1					1
<i>Pseudocyphellaria rainierensis</i>	1				1					1
<i>Sphaerophorus globosus</i>	1				1					
<i>Sticta weigeli</i>	1				1					1
<i>Usnea longissima</i>	1	1	1	1	1	1				1
<i>Teloschistes flavicans</i>	1	1	1	1	1	1				1

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Liverworts

<i>Herbertus aduncus</i>	1				1	1				1
<i>Herbertus sakuraii</i>	1	1	1	1	1	1				1
<i>Ptilidium californicum</i> (CA only)	1	1	1	1	1					1
<i>Ptilidium californicum</i> (OR & WA)					1					
<i>Radula bolanderi</i>					1					
<i>Scapania bolanderi</i>					1					

Mosses

<i>Antitrichia curtipendula</i>	1				1					
<i>Iwatsukiella leucotricha</i>	1	1	1	1	1	1				1
<i>Pterigynandrum filiforme</i>	1				1	1				1
<i>Ulota megalospora</i> (CA only)	1	1	1	1	1	1				1

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

2. Decaying wood

Lichens

<i>Icmadophila ericetorum</i>	1				1					1
-------------------------------	---	--	--	--	---	--	--	--	--	---

Liverworts

<i>Bazzania ambigua</i>	1				1					
<i>Bazzania denudata</i>	1				1					
<i>Bazzania tricrenata</i>	1				1					
<i>Blepharostoma trichophyllum</i>	1				1					
<i>Calypogeia azurea</i>	1				1					
<i>Calypogeia fissa</i>	1				1					
<i>Calypogeia muelleriana</i>	1				1					
<i>Calypogeia suecica</i>	1				1					
<i>Cephalozia bicuspidata</i> ssp. <i>lammersiana</i>	1				1					
<i>Cephalozia connivens</i>	1				1					
<i>Cephalozia lunulifolia</i>	1				1					
<i>Diplophyllum albicans</i>	1				1					
<i>Diplophyllum plicatum</i>	1				1					
<i>Geocalyx graveolens</i>	1				1					
<i>Kurzia makinoana</i>	1				1					
<i>Lepidozia reptans</i>	1				1					
<i>Lophocolea bidentata</i>	1				1					
<i>Lophocolea cuspidata</i>	1				1					
<i>Lophocolea heterophylla</i>	1				1					
<i>Lophozia incisa</i>	1				1					
<i>Lophozia longiflora</i>	1				1					
<i>Riccardia latifrons</i>	1				1					
<i>Riccardia palmata</i>	1				1					
<i>Scapania umbrosa</i>	1				1					

Mosses

<i>Brotherella roellii</i> (WA Cascades only)	1	1	1	1	1	1	1	1	1	1
<i>Buxbaumia piperi</i>	1	1	1	1	1	1				1
<i>Buxbaumia viridis</i>	1	1	1	1	1	1				1
<i>Herzogiella seligeri</i>	1					1				
<i>Orthodontium gracile</i> (Redwoods no. CA)	1					1				

Species with Viability Risk

All taxonomic classes

file 'applist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E
<i>Plagiothecium undulatum</i>	1				1					
<i>Pseudotaxiphyllum elegans</i>	1				1					
<i>Rhizomnium glabrescens</i>	1				1					
<i>Tetraphis geniculata</i>	1	1	1	1	1	1				1
<i>Tetraphis pellucida</i>	1				1					

Species with Viability Risk

All taxonomic classes

file 'applist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

3. Soil and bases of trees

Liverworts

<i>Scapania americana</i>	1				1					
---------------------------	---	--	--	--	---	--	--	--	--	--

Mosses

<i>Anthoceros bulbiculosus</i>	1				1					
<i>Bartramiaopsis lescurei</i>	1	1	1	1	1	1	1	1	1	1
<i>Brachythecium hylotapetum</i>	1				1					1
<i>Ditrichum schimperi</i>	1				1					
<i>Epipterygium tozeri</i>	1				1					
<i>Fissidens pauperculus</i>	1				1					
<i>Isopterygiopsis pulchella</i>	1				1	1				1
<i>Plagiomnium insigne</i>	1				1					
<i>Pohlia pacifica</i>	1				1					
<i>Rhizomnium nudum</i>	1	1	1	1	1	1				1
<i>Rhytidiopsis robusta</i>	1				1					
<i>Roellia roellii</i>	1				1					
<i>Schistostega pennata</i>	1	1	1	1	1	1				1
<i>Trichodon cylindricus</i>	1				1					

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

4. Rock

Liverworts

<i>Apometzgeria pubescens</i>	1	1	1	1	1	1				1
<i>Metzgeria conjugata</i>	1	1	1	1	1	1				1
<i>Radula brunnea</i>	1	1	1	1	1	1				1

Mosses

<i>Andreaea heinemanii</i>	1				1					1
<i>Andreaea schofieldiana</i>	1				1					1
<i>Byrum gemmascens</i>	1				1	1				1
<i>Heterocladium macounii</i>	1				1	1				1
<i>Heterocladium procurrens</i>	1				1	1				1
<i>Plagiothecium piliferum</i>	1				1	1				1

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

5. Water

Liverworts

<i>Conocephalum conicum</i>	1				1					
<i>Pellia neesiana</i>	1				1					
<i>Tritomaria exsecta</i>	1				1					
<i>Tritomaria exsectiformis</i>	1				1					
<i>Tritomaria quinquedentata</i>	1	1	1	1	1	1				1

Mosses

<i>Dichodontium pellucidum</i>	1				1					
<i>Dicranella palustra</i>	1	1			1	1				1
<i>Hookeria lucens</i>	1				1					
<i>Hygrohypnum bestii</i>	1	1			1	1				1
<i>Pleuroziopsis ruthenica</i>	1	1	1	1	1	1	1	1	1	1
<i>Porotrichum bigelovii</i>	1				1					
<i>Rhytidiadelphus subpinnatus</i>	1				1					

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

6. Other

Fungi

<i>Albatrellus caeryliopus</i>	1	1	1		1					1
<i>Aleuria rhenana</i>	1	1	1	1	1	1	1	1	1	
<i>Catathelasma ventricosa</i>	1	1	1		1					1
<i>Collybia bakerensis</i>	1				1	1				1
<i>Collybia racemosa</i>	1	1			1	1				1
<i>Cortinarius boulderensis</i>	1	1	1		1					1
<i>Cortinarius cyanites</i>	1	1	1		1					1
<i>Cortinarius olympianus</i>	1	1	1		1					1
<i>Cortinarius rainerensis</i>	1	1	1		1					1
<i>Cortinarius tabularis</i>	1	1	1		1					1
<i>Cortinarius variipes</i>	1	1	1		1					1
<i>Cortinarius valgius</i>	1	1	1		1					1
<i>Ganoderma tsugae</i>	1				1	1				1
<i>Ganoderma oregana</i>	1				1	1				1
<i>Geopora cooperi</i>	1				1	1				1
<i>Gomphus kauffmanii</i>	1	1	1		1					1
<i>Gymnopilus punctifolius</i>	1				1	1				1
<i>Hericium abietis</i>	1				1	1				1
<i>Laetiporus sulfureus</i>	1				1	1				1
<i>Mycena lilacifolia</i>	1				1	1				1
<i>Mycena marginella</i>	1				1	1				1
<i>Mythicomyces corneipes</i>	1	1			1	1				1
<i>Otidea leporina</i>	1	1			1	1				1
<i>Otidea onotica</i>	1	1			1	1				1
<i>Otidea smithii</i>	1	1			1	1				1
<i>Oxyporus nobilissimus</i>	1				1	1				1
<i>Phaeocollybia kauffmanii</i>	1		1		1					1
<i>Pholiota scamba</i>	1				1	1				1
<i>Pholiota pulchella</i>	1				1	1				1
<i>Pleurocybella porrigens</i>	1				1	1				1
<i>Polyozellus multiplex</i>	1	1	1		1					1
<i>Rhodocybe speciosa</i>	1				1	1				1
<i>Sarcosphaera eximia</i>	1				1					1
<i>Sarcosoma mexicana</i>	1	1			1	1				1

Species with Viability Risk

All taxonomic classes

file 'applist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

<i>Sparaxis radicata</i>	1				1	1				1
<i>Tricholomopsis fulvescens</i>	1				1	1				1

Mosses

<i>Ulota obtusiuscula</i>					1					
---------------------------	--	--	--	--	---	--	--	--	--	--

TOTAL non-vasc.	133	38	31	19	147	49	4	4	4	82
------------------------	------------	-----------	-----------	-----------	------------	-----------	----------	----------	----------	-----------

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Vascular plants

<i>Allotropa virgata</i>	1				1					
<i>Chamaecyparis lawsoniana</i> (so.)	1				1					1
<i>Coptis asplenifolia</i>					1					
<i>Cypripedium fasciculatum</i>			1	1						
<i>Cypripedium montanum</i>			1	1						
<i>Pyrola uniflora</i>	1				1					
<i>Taxus brevifolia</i> (nw Cal.)	1				1					

TOTAL vascular	4	0	2	2	5	0	0	0	0	1
-----------------------	---	---	---	---	---	---	---	---	---	---

Species with Viability Risk

All taxonomic classes

file 'applist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Invertebrates

(Not rated by alternative)

Phylum Arthropoda

Class Diplopoda (millipedes)

Order Chordeumatida

Family Caseyidae

<i>Caseya benedictae</i>
<i>Caseya briophila</i>
<i>Caseya bucketti</i>
<i>Caseya longiloba</i>
<i>Caseya megasoma</i>
<i>Caseya megasoma</i>
<i>Caseya shastaensis</i>
<i>Harpaphe haydeniana</i>
<i>Metopiona sheari</i>
<i>Ochrogramma heterogona</i>
<i>Ochrogramma formulosa</i>
<i>Ochrogramma haigi</i>
<i>Opiona bifurcata</i>
<i>Opiona casualis</i>
<i>Opiona communis angusta</i>
<i>Opiona confusa</i>
<i>Opiona distincta</i>
<i>Opiona exigua</i>
<i>Opiona facelia</i>
<i>Opiona fisheri</i>
<i>Opiona goedeni</i>
<i>Opiona scytonotoides</i>
<i>Opiona siliquae</i>
<i>Tuhaphe levii</i>

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Class Arachnida

Order Araneida (spiders)

Family Agelenidae

Cybaeina minuta

Order Phalangida (harvestman)

Cryptomaster leviathan

Isolachus spinosus

Pentanychus hamatus

Pentanychus clavatus

Pentanychus bilobatus

Pentanychus flavescens

Pentanychus pacificus

Class Insecta (insects)

Order Orthoptera

Boonacris alticola

Pristoceuthophilus celatus

Pristoceuthophilus cercalis

Pristoceuthophilus sargentae

Tropidischia xanthostoma

Order Hemiptera

Boreostolis americanus

Plinthisus longisetosus

Thylochromus nitidulus

Eurychilopterella sp.

Phytocoris nobilis

Pithanus maerkelii

Polymerus castellaeni

Vanduzeeenia borealis

Acalypta lillianis

Acalypta saundersi

Derephysia foliacea

Order Coleoptera

Pterecus humboldti

Cychrus tuberculatus

Metrius contractus

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

<i>Promecognathus laevissimus</i>
<i>Zacotus mathewsii</i>
<i>Omus dejeani</i>
<i>Lobosoma horridum</i>
<i>Acneus beeri</i>
<i>Acneus burnelli</i>
<i>Cicindela columbica</i>
<i>Pterostichus rothi</i>

Order Plecoptera

<i>Nemoura wahkeena</i>
<i>Solperia fenderi</i>

Order Trichoptera

<i>Eobrachycentrus gelidae</i>
<i>Agapetus denningi</i>
<i>Homoplecta schuhi</i>
<i>Ochrotrichia alsea</i>
<i>Lepidostoma goedeni</i>
<i>Apatania tavaia</i>
<i>Farula davisi</i>
<i>Farula jewetti</i>
<i>Farula reaperi</i>
<i>Limnephilus alconura</i>
<i>Limnephilus atereus</i>
<i>Neothremma andersoni</i>
<i>Oligophlebodes mostbento</i>
<i>Philocasca oron</i>
<i>Dolophilodes oregona</i>
<i>Tinodes siskyou</i>
<i>Rhyacophila ambilis</i>
<i>Rhyacophila colonus</i>
<i>Rhyacophila fenderi</i>
<i>Rhyacophila haddocki</i>
<i>Rhyacophila lineata</i>
<i>Rhyacophila mosana</i>
<i>Rhyacophila unipunctata</i>
<i>Desmona bethula</i>
<i>Cryptochia shasta</i>

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

<i>Goeracea oregona</i>
<i>Neothremma genella</i>
<i>Neothremma siskyou</i>
<i>Ochrotrichia vertreesi</i>
<i>Abellan hydropsycha</i>

Phylum Mollusca

<i>Fluminicola columbiana</i>
<i>Fisherola nuttalli nuttalli</i>
<i>Monadenia fidelis minor</i>
<i>Monadenia troglodytes chaceana</i>
<i>Monadenia troglodytes troglodytes</i>
<i>Monadenia troglodytes wintu</i>
<i>Monadenia fidelis pronotis</i>
<i>Monadenia setosa</i>
<i>Vespericola karokorum</i>
<i>Juga hemphilli hemphilli</i>
<i>Juga hemphilli dallesensis</i>
<i>Juga hemphilli subsp.</i>
<i>Juga (J.) n. sp. 1</i>
<i>Juga (J.) n. sp. 3</i>
<i>Juga (O.) n. sp. 1</i>
<i>Juga (O.) n. sp. 2</i>
<i>Juga (C.) actifilosa</i>
<i>Juga (C.) occata</i>
<i>Amnicola (L.) n. sp.</i>
<i>Vorticifex neritoides</i>
<i>Physella columbiana</i>
<i>Fluminicola seminalis</i>
<i>Lanx alta</i>
<i>Lanx patelloides</i>
<i>Helisoma newberryi newberryi</i>
<i>Vespericola columbiana columbiana</i>
<i>Hemphillia malonei</i>
<i>Hemphillia pantherina</i>

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

<i>Hemphillia glandulosa glandulosa</i>
<i>Hemphillia barringtoni</i>
<i>Prophysaon coeruleum</i>
<i>Prophysaon dubium</i>
<i>Monadenia fidelis columbiana</i>
<i>Monadenia fidelis beryllica</i>
<i>Monadenia fidelis celeuthia</i>
<i>Monadenia fidelis ochromphalous</i>
<i>Monadenia fidelis leonina</i>
<i>Monadenia fidelis klamathica</i>
<i>Monadenia churchi</i>
<i>Trilobopsis roperi</i>
<i>Trilobasis tehamana</i>
<i>Vespericola shasta</i>
<i>Vespericola sierrana</i>
<i>Vespericola megasoma euthales</i>
<i>Megomphix hemphilli</i>
<i>Anodonta wahlametensis</i>
<i>Juga (Oreobasis) chacei</i>
<i>Juga (Oreobasis) orickensis</i>
<i>Lanx subrotundata</i>
<i>Monadenia callipeplus</i>
<i>Monadenia cristulata</i>
<i>Monadenia fidelis salmonensis</i>
<i>Monadenia fidelis scottiana</i>
<i>Monadenia rotifera</i>
<i>Haplotrema voyanum</i>
<i>Helminthoglypta hertleini</i>
<i>Deroceras hesperium</i>
<i>Anodonta californiensis</i>

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

17 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Fish

(see report)

No. of fish stocks at risk:	112	112	112	112	112	112	112	112	112	112
-----------------------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Herps

Amphibians

Oregon Slender salamander	1				1					1
Larch Mt. salamander	1	1	1	1	1	1				1
Siskiyou Mt. salamander	1	1	1	1	1	1	1	1	1	1
Del Norte salamander	1	1	1		1	1				1
Van Dyke's salamander (Coastal, Olym. Pe	1	1	1	1	1	1	1	1	1	1
Van Dyke's salamander (Cascades)	1	1	1	1	1	1	1	1	1	1
Dunn's salamander	1				1					
Black salamander	1				1					1
Clouded salamander (Oregon)	1				1					1
Clouded salamander (California)	1	1			1					1
Pacific giant salamander	1				1					1
Cope's giant salamander	1				1					1
Olympic salamander (R.olympicus)	1	1	1		1	1				1
Olympic salamander (R.kezeri)	1	1	1	1	1	1	1	1	1	1
Olympic salamander (R. cascadae)	1	1	1	1	1	1	1	1		1
Olympic salamander (R. variegatus)	1	1	1	1	1	1	1	1	1	1
Northwestern salamander	1				1					1
Shasta salamander	1	1	1	1	1	1	1	1	1	1
Roughskin newt	1				1					
Tailed frog	1	1	1		1	1				1

TOTAL herps	20	12	11	8	20	11	7	7	6	18
-------------	----	----	----	---	----	----	---	---	---	----

Reptiles

(no species)

0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---

Species with Viability Risk

All taxonomic classes

file 'applist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Birds

Marbled murrelet	1	1	1	1	1	1	1	1	1	1
Barrow's goldeneye	1				1					
Bufflehead	1	1	1	1	1					
Harlequin duck	1	1	1		1					
Northern goshawk	1	1			1	1				1
Northern pygmy-owl	1				1					
Flammulated owl	1	1	1	1	1					1
Great gray owl	1	1	1	1	1					
Vaux's swift	1				1					
Pileated woodpecker	1				1					
White-headed woodpecker	1	1	1	1	1					1
Black-backed woodpecker	1	1			1					1
Three-toed woodpecker	1									
Red-breasted sapsucker	1				1					
Williamson's sapsucker	1				1					
Hammond's flycatcher	1				1					1
Pygmy nuthatch	1	1	1	1	1					
Red crossbill					1					

TOTAL birds	17	9	7	6	17	2	1	1	1	6
--------------------	----	---	---	---	----	---	---	---	---	---

Species with Viability Risk

All taxonomic classes

file 'spplist.wq1'

8 Dec 1992

Alternative:	High viability risk					Extirpation risk				
	A	B	C	D	E	A	B	C	D	E

Mammals

Marten (Olympic Peninsula)	1	1	1	1	1	1	1			1
Marten (Washington Cascades)	1				1					
Marten (Oregon Coast range)	1	1	1	1	1	1	1			1
Marten (Oregon Cascades)	1	1	1		1					1
Marten (Klamath Province)	1				1					
Fisher (CA, so. OR)	1	1	1		1	1				1
Fisher (no. OR, WA)	1	1	1	1	1	1	1	1	1	1
Red tree vole (P.longicaudus)	1	1	1	1	1	1	1	1		1
Red tree vole (P.pomo)	1	1	1	1	1	1	1	1		1
Big brown bat	1				1					
Silver-haired bat	1				1					1
Lynx	1	1	1	1	1	1				1

TOTAL mammals	12	8	8	6	12	7	5	3	1	9
---------------	----	---	---	---	----	---	---	---	---	---

1 = denotes viability risk

blank = denotes no viability risk

Appendix 6-I. Comparison of species lists of terrestrial vertebrates:
Final EIS and Scientific Analysis Team

Comparison of Species Lists of Terrestrial Vertebrates: Final EIS and SAT

file '32&SAT.WQ1

9 Dec 1992

List of species with viability
risk under 1 or more alternatives
from SAT evaluation.

On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B viab. con- cern?	Alt. B extirp. con- cern?
--------------------------------------	----------------------------	-----------------------------	----------------------------------	------------------------------------

Herps

Amphibians

Oregon Slender salamander		X	X		
Larch Mt. salamander		X	X	X	
Siskiyou Mt. salamander		X	X	X	X
Del Norte salamander	X	X	X	X	
Van Dyke's salamander (Coast., Oly. Pen.)		X	X	X	X
Van Dyke's salamander (Cascades)		X	X	X	X
Dunn's salamander		X	X		
Black salamander	X	X	X		
Clouded salamander (Oregon)		X	X		
Clouded salamander (California)		X	X	X	
Pacific giant salamander		X	X		
Cope's giant salamander		X	X		
Olympic salamander (R.olympicus)	X	X	X	X	
Olympic salamander (R.kezeri)	X	X	X	X	X
Olympic salamander (R. cascadae)	X	X	X	X	X
Olympic salamander (R. variegatus)	X	X	X	X	X
Northwestern salamander	X	X	X		
Shasta salamander		X	X	X	X
Roughskin newt	X	X	X		
Tailed frog	X	X	X	X	

Reptiles

(no species)

Comparison of Species Lists of Terrestrial Vertebrates: Final EIS and SAT

file '32&SAT.WQ1

9 Dec 1992

List of species with viability
risk under 1 or more alternatives
from SAT evaluation.

On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B viab. con- cern?	Alt. B extirp. con- cern?
--------------------------------------	----------------------------	-----------------------------	----------------------------------	------------------------------------

Birds

Marbled murrelet	X	X	X	X	X
Barrow's goldeneye		X	X		
Bufflehead		X	X	X	
Harlequin duck		X	X	X	
Northern goshawk	X	X	X	X	
Bald eagle	X	X	X		
Northern pygmy-owl		X	X		
Flammulated owl		X	X	X	
Great gray owl		X	X	X	
Vaux's swift	X	X	X		
Pileated woodpecker		X	X		
Hairy woodpecker	X	X	X		
White-headed woodpecker		X	X	X	
Black-backed woodpecker		X	X	X	
Three-toed woodpecker		X	X		
Red-breasted sapsucker	X	X	X		
Williamson's sapsucker		X	X		
Hammond's flycatcher		X	X		
Western flycatcher	X	X	X		
Winter wren	X	X	X		
Pygmy nuthatch		X	X	X	
Chestnut-backed chickadee	X	X	X		
Golden-crowned kinglet	X	X	X		
Brown creeper	X	X	X		
Hermit warbler	X	X	X		
Varied thrush	X	X	X		
Red crossbill		X	X		

Comparison of Species Lists of Terrestrial Vertebrates: Final EIS and SAT

file '32&SAT.WQ1

9 Dec 1992

List of species with viability
risk under 1 or more alternatives
from SAT evaluation.

On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B viab. con- cern?	Alt. B extirp. con- cern?
--------------------------------------	----------------------------	-----------------------------	----------------------------------	------------------------------------

Mammals

Marten (Olympic Peninsula)		X	X	X	X
Marten (Washington Cascades)		X	X		
Marten (Oregon Coast range)		X	X	X	X
Marten (Oregon Cascades)		X	X	X	
Marten (Klamath Province)		X	X		
Fisher (CA, so. OR)	X	X	X	X	
Fisher (no. OR, WA)	X	X	X	X	X
Pacific shrew	X	X	X		
Douglas squirrel	X	X	X		
Western red-backed vole	X	X	X		
Shrew-mole	X	X	X		
Red tree vole (P.longicaudus)	X	X	X	X	X
Red tree vole (P.pomo)	X	X	X	X	X
Big brown bat	X	X	X		
Silver-haired bat	X	X	X		
Fringed myotis	X	X	X		
Little brown bat	X	X	X		
Yuma myotis	X	X	X		
California myotis	X	X	X		
Keen's myotis	X	X	X		
Lynx		X	X	X	

Appendix 6-J. Species needing further information

Species Needing Further Information

file 'sppinfo.wq1'

12 Dec 1992

Species with at least 3 panelists denoting insufficient scientific information by which to rank viability effects.

Species	Highest priority ranking (unknown)
---------	---

NON-VASCULAR PLANTS

1. Live wood

Lichens

<i>Bacidia herrei</i>	X
<i>Calicium abietinum</i>	
<i>Calicium adaequatum</i>	
<i>Calicium adpersum</i>	
<i>Calicium glaucellum</i>	
<i>Calicium viride</i>	
<i>Cavernularia hultenii</i>	X
<i>Cavernularia lophyrea</i>	X
<i>Cetraria californica</i>	X
<i>Cetrelia cetrarioides</i>	X
<i>Chaenotheca chrysocephala</i>	
<i>Chaenotheca ferruginea</i>	
<i>Chaenotheca subroscida</i>	
<i>Collema nigrescens</i>	X
<i>Dendroscocaulon intricatum</i>	X
<i>Heterodermia leucomelos</i>	X
<i>Hypocenomyce friesii</i>	X
<i>Hypogymnia duplicata</i>	X
<i>Hypogymnia oceanica</i>	X
<i>Hypogymnia rugosa</i>	X
<i>Leptogium cyanescens</i>	X
<i>Lichinodium canadense</i>	X
<i>Lopadium pezizoideum</i>	X
<i>Microcalicium arenarium</i>	
<i>Pannaria leucostictoides</i>	
<i>Pannaria rubiginosa</i>	X
<i>Pannaria saubinetii</i>	X
<i>Parmotrema chinense</i>	X

<i>Parmotrema crinitum</i>	X
<i>Platismatia norvegica</i>	X
<i>Ramalina thrausta</i>	X
<i>Teloschistes flavicans</i>	

Liverworts

<i>Douinia ovata</i>	X
----------------------	---

Mosses

<i>Pseudoleskea stenophylla</i>	
---------------------------------	--

2. Decaying wood

Mosses

<i>Pseudoleskea saviana</i>	
-----------------------------	--

3. Soil and bases of trees

Lichens

<i>Peltigera neopolydactyla</i>	X
<i>Peltigera pacifica</i>	X

Mosses

<i>Anthoceros bulbiculosus</i>	
<i>Fissidens pauperculus</i>	
<i>Pohlia pacifica</i>	

4. Rock

Mosses

<i>Byrum gemmascens</i>	
<i>Lecuræa incurvata</i>	
<i>Pseudoleskea incurvata</i>	
<i>Pseudoleskea patens</i>	
<i>Pseudoleskea radicata</i>	
<i>Thamnobryum neckeroides</i>	

5. Water

(no species)

6. Other

Fungi

<i>Aleuria rhenana</i>	
<i>Collybia racemosa</i>	
<i>Elaphomyces granulatus</i>	
<i>Elaphomyces muricatus</i>	X
<i>Geopora cooperi</i>	
<i>Hysterangium crassirhachis</i>	
<i>Hysterangium setchellii</i>	X
<i>Mythicomycetes corneipes</i>	
<i>Otidea leporina</i>	
<i>Otidea onotica</i>	
<i>Otidea smithii</i>	
<i>Rhizopogon atrovioleaceus</i>	X
<i>Sarcosoma mexicana</i>	
<i>Tuber rufum</i>	X

VASCULAR PLANTS

Saprophytes

<i>Hemitomes congestum</i> (entire range)	
<i>Hemitomes congestum</i> (so.)	
<i>Pityopsis californica</i>	
<i>Pleuricospora fimbriolata</i>	
<i>Sarcodes sanguinea</i>	

Orchids

<i>Cypripedium fasciculatum</i>	
<i>Cypripedium montanum</i>	
<i>Listera borealis</i>	X
<i>Platanthera obtusata</i>	X
<i>Platanthera sparsiflora</i>	X

Grape ferns

<i>Botrychium ascendens</i>	
<i>Botrychium crenulatum</i>	
<i>Botrychium minganense</i>	
<i>Botrychium montanum</i>	
<i>Botrychium pumicola</i>	

Heaths

<i>Gaultheria humifusa</i>	
<i>Pyrola chlorantha</i>	
<i>Pyrola uniflora</i>	

Conifer Priority Species

<i>Chamaecyparis lawsoniana</i> (so.)	
---------------------------------------	--

Other Conifers

<i>Picea breweriana</i>	
-------------------------	--

Ferns

<i>Gymnocarpium dryopteris</i>	
<i>Polystichum munitum</i> var. <i>imbricans</i>	

Grasses

<i>Poa laxiflora</i>	
----------------------	--

Others with Listing Status

<i>Asarum wagneri</i>	X
<i>Bensoniella oregana</i>	
<i>Cimicifuga elata</i>	
<i>Coptis asplenifolia</i>	
<i>Fritillaria gentneri</i>	X
<i>Galium kamtschaticum</i>	
<i>Haplopappus Whitneyi discoides</i> (no. CA)	
<i>Silene nuda</i>	X
<i>Trillium ovatum</i> ssp. <i>oettingeri</i>	
<i>Viola renifolia</i>	X

Others Without Listing Status

<i>Angelica tomentosa</i>	X
<i>Apocynum pumilum</i>	
<i>Arceuthobium tsugense</i>	
<i>Berberis pumila</i>	X
<i>Coptis laciniata</i>	
<i>Dentaria californica</i>	
<i>Erythronium montanum</i>	
<i>Hieracium scouleri</i>	
<i>Lathyrus polyphyllus</i>	
<i>Luzula hitchcockii</i>	
<i>Mitella breweri</i>	
<i>Selaginella oregana</i>	
<i>Streptopus streptopoides</i>	
<i>Synthyris schizantha</i>	X
<i>Vancouveria planipetala</i>	
<i>Vicia americana</i> var. <i>villosa</i>	

INVERTEBRATES

(most poorly known and require study)

FISH

(see Sedell and Reeves papers)

TERRESTRIAL VERTEBRATES

Herps

Amphibians

Van Dyke's salamander (Coastal, Olym. Penin.)	
Van Dyke's salamander (Cascades)	
Black salamander	
Cope's giant salamander	
Shasta salamander	

Reptiles

0 reptile forms	
-----------------	--

Birds

Flammulated owl	
Great gray owl	
White-headed woodpecker	
Black-backed woodpecker	
Three-toed woodpecker	
Williamson's sapsucker	
Pygmy nuthatch	

Mammals

Fisher (CA, so. OR)	X
Fisher (no. OR, WA)	X
Red tree vole (P.pomo)	
Hoary bat	
Long-legged myotis	
Yuma myotis	
California myotis	
Keen's myotis	X
Long-eared myotis	
Fringed myotis	
Little brown myotis	

Additional Mammals

Pallid bat	
Wolverine	X

CHAPTER 6

APPENDIX K

OTHER SPECIES: FISH

Other Species
Fish Appendix

Outline

- I. Introduction
- II. Characteristics of Fish Habitat in Northern Spotted Owl Forests
 - A. Characteristics of Good Habitat
 - 1. Water Quality
 - 2. Water Quantity
 - 3. Channel Characteristics
 - 4. Riparian Vegetation
 - 5. Watershed Conditions
 - B. Current Fish Habitat Conditions
 - C. Causes and Implications of Habitat Degradation
 - 1. Large Wood
 - 2. Habitat Complexity
 - 3. Water Temperature
 - 4. Sediments
 - 5. Rate of Habitat Recovery
- III. Conservation Strategy for Fish Habitat in Northern Spotted Owl Forests
 - A. Rationale and Basis for Conservation Strategy
 - B. Components of the Fish Habitat Conservation Strategy
 - 1. Component 1: Designated Lands Providing Habitat Protection
 - 2. Component 2: Watershed Protection Areas (WPA)
 - 3. Interim Widths of WPAs for Different Water Bodies
 - 4. Component 3: Watershed Analysis
 - 5. Component 4: Watershed Restoration
 - 6. Summary
- IV. Standards and Guidelines
 - Timber Management
 - Roads Management
 - Grazing Management
 - Recreation Management
 - Minerals Management
 - Fire/Fuels Management
 - Lands
 - General Riparian Area Management
 - Watershed and Habitat Restoration

V. Tables and Figures

Table 6-K-1 Spawning and Stream Rearing Habitat Factors Potentially Limiting Natural Production for Coastal Oregon Anadromous Salmonid Species.

Table 6-K-2 Species of Anadromous Salmonids Found on National Forests Within the Range of the Northern Spotted Owl

Table 6-K-3 Changes in the Frequency of Deep Pools in Streams Within the Northern Spotted Owl Forests From 1935 to 1992

Table 6-K-4 Changes in the Frequency of Large Pools in the Western Cascades Province of the Northern Spotted Owl Forests From 1935 to 1992

Figure 6-K-1 Range and Status of Anadromous Salmonid Stocks at Risk in Northern California, Oregon, Washington and Idaho.

Figure 6-K-2 Schematic Diagram of a Watershed Protection Area

Figure 6-K-3 Location of Key Watersheds in California and Status of Anadromous Salmonid Stocks Within Streams

Figure 6-K-4 Location of Key Watersheds in Oregon and Status of Anadromous Salmonid Stocks and Other Forests.

Figure 6-K-5 Location of Key Watersheds in Washington and Status of Anadromous Salmonid Stocks and Other Fishes

VI. Literature Cited

APPENDIX 6-K - FISH

STRATEGY FOR MANAGING HABITAT OF PACIFIC SALMON AND TROUT ON NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

INTRODUCTION

Many stocks of anadromous salmonids (Oncorhynchus spp.) are presently in precarious conditions. (A stock is a locally adapted population that is reproductively isolated from other stocks [Ricker 1972]). The Endangered Species Committee of the American Fisheries Society recently identified 214 stocks in California, Oregon, Washington, and Idaho that are in need of special management considerations because of low or declining numbers (Nehlsen et al. 1991). Figure 6-K-1 shows the distribution and status of these stocks in the area of the northern spotted owl. One, the Sacramento River winter chinook salmon (Oncorhynchus tshawytscha), has been listed under the Endangered Species Act. One hundred one others were believed to face a high risk of extinction and 58 a moderate risk. An additional 106 stocks are believed to already be extinct (Nehlsen et al. 1991). Higgins et al. (1992) identified an additional 18 stocks in northern California that were not considered by Nehlsen et al. (1991) and whose numbers are low or declining.

The status of anadromous fish stocks in northern California, Oregon, Washington, and Idaho reflects the condition of fish throughout North America. Concern about biodiversity has focused on the tropics, but the loss of temperate species rivals that observed in the tropics. This is particularly true for freshwater fish in western North America (Allendorf 1988). Williams et al. (1989) listed 364 species and subspecies of fish in North America that are in need of special management considerations because of low numbers. This is an increase of 139 species since 1979. They noted that no species were removed from the list because of successful recovery programs. Moyle and Williams (1990) found that 57% of the native freshwater fish of California were extinct or in need of immediate action.

The primary factors contributing to the demise of anadromous salmonid stocks include: (1) degradation and loss of freshwater and estuarine habitats from urbanization, agriculture, livestock grazing, mining, timber harvest, and dams; (2) over exploitation in commercial and recreational fisheries; (3) migratory impediments such as dams; and (4) loss of genetic integrity due to influence of hatchery practices and introduction of non-local stocks. Often two or more of these factors operating in concert are responsible for the decline in stock numbers. Loss and degradation of freshwater habitats are the most frequent factors responsible for the decline of anadromous salmonids stocks (Nehlsen et al. 1991). This includes decreases in the quantity and quality of habitat and the fragmentation of habitat into isolated patches. The demise of other fish species is also attributable to factors responsible for the state of anadromous salmonid stocks (Williams et al. 1989, Moyle and Williams 1990).

A conference of management agencies and interested individuals and groups was convened recently by the Governor of Oregon, Barbara Roberts (Oregon Governor's Coastal Salmonid Restoration Initiative, Newport, Oregon, 15-17 December 1992). For this conference a panel of biologists from state and federal

agencies, universities, and private industries was asked to assess the degree to which various factors limit production of the wild species and stocks of anadromous salmonids in coastal Oregon (coho, chinook, and chum salmon; steelhead; and sea-run cutthroat trout). The intent was to provide the basis for developing programs to protect and restore the production of these fish.

Results of the assessment of limiting natural production for freshwater components, spawning and rearing habitat, are shown in Table 6-K-1. Spawning gravel quantity and quality were rated as having a high potential for limiting production of chum salmon and fall and spring chinook (Table 6-K-1). Gravel quality was believed to be poor because it was unstable (i.e. gravel containing developing eggs and alevins was subjected to movement during higher flows resulting in dislodgement or burial of eggs and alevins). Coho salmon production had a medium potential to be limited by gravel quantity and quality (Table 6-K-1). For coho salmon, gravel quantity was the responsible factor for the assessment. Lack of gravel in many streams appeared to be a consequence of both historic activities, such as splash damming which flushed gravels, and recent activities, such as stream channel clearance, that reduced or eliminated the amount of large wood which served to trap sediments in coastal streams.

Many facets of rearing habitat were identified as having high potentials to limit every species and race except fall chinook salmon (Table 6-K-1). Increased water temperature was a factor along the south coast. Reduced numbers of deep complex pools and large sized wood in streams have resulted in a simplified rearing habitat which has a high potential for limiting several species and life history stages. Wetland and estuarine rearing areas have also been degraded. Riparian areas have very few large trees growing within 100 to 200 feet of the stream, indicating the streamside recruitment of large wood will be decades off. Alteration of both high and low streamflows caused by irrigation withdrawal, forest management activities, and stream channel simplification has limited the natural productivity of many streams. Species and stocks that reared in fresh water for extended periods in were believed to be most affected. The evaluation of factors limiting production of the wild species and stocks of anadromous salmonids in coastal Oregon presented at the Governor's conference is the most extensive and detailed current evaluation in the coastal owl forests. While it is a subjective assessment, it drew upon the expertise and judgement of dozens of resource specialists, scientists, and fisheries managers.

CHARACTERISTICS OF FISH HABITAT IN THE NORTHERN SPOTTED OWL FORESTS

Characteristics of Good Habitat

Assemblages of anadromous salmonids associated with forests in the range of the northern spotted owl include five species of Pacific salmon and two trouts (Table 6-K-2). Each species has a variable number of discrete stocks that are genetically isolated from each other and specifically adapted to local habitat characteristics. It is quite common for several species and numerous stocks to coexist in the same sections of stream systems throughout their range. As a result, the anadromous salmonid assemblage of most aquatic systems is a complex mixture of several species and stocks. Each species and stock has exacting but slightly different habitat requirements (see Bjornn and Reiser 1991), necessitating diverse and complex habitats to maintain populations of all groups.

The life history of anadromous salmonids adds to the complexity of freshwater habitat needs. All anadromous salmonids spawn in freshwater, and juvenile fish rear in streams and lakes for variable periods of time before moving to the ocean where they grow to adulthood (see Meehan and Bjornn 1991, Groot and Margolis 1991). Some species reside in freshwater for only a few weeks, but more commonly, juveniles reside in freshwater for one to several years, growing in size to 20 cm (8 inches) or more before entering the ocean. Freshwater habitats must often accommodate several species and age-classes of fish through all times of the year. Habitat needs are different for each species, age- and size-classes of juvenile fish, and each season of the year (Bjornn and Reiser 1991, Groot and Margolis 1991). Therefore, freshwater habitats must provide good water quality and quantity and a wide variety of substrates and habitat types, cover, and food resources to accommodate the habitat needs of mixed anadromous salmonid assemblages.

Freshwater habitat requirements of anadromous salmonids have been well documented in the scientific literature (see Bjornn and Reiser 1991, Groot and Margolis 1991). A weakness of the documentation, however, is that habitat descriptions are species specific and do not take into account that almost all habitats used by anadromous fish must accommodate complex assemblages of species and stocks rather than a single species or stock. The more complex the salmonid community, the more complex the habitat needed to meet the requirements of all species and sizes of fish at all seasons of the year.

The following characteristics productive natural habitats for anadromous salmonids applies to 3rd- to 5th-order watersheds (Strahler 1957) supporting mixed species communities of anadromous salmonids. (This is the general range of watershed sizes managed by the USDA Forest Service in the range of the northern spotted owl.) Not all of the desired features are expected to occur in a specific reach of stream within a watershed, but generally will occur throughout a productive watershed. Factors such as climate and geology can exert strong influences on productivity of streams and influence fish habitat. Although these are beyond human control (Naiman et al. 1992), their effects must be considered in any management decisions.

Water Quality

All salmonids require consistently excellent quality water for spawning, rearing, and migration (Bjornn and Reiser 1991). An abundance of cool

(generally $<20^{\circ}\text{C}$ [68°F]), well-oxygenated water, free of excessive amounts of suspended sediments (Sullivan et al. 1987) and other pollutants is required at all seasons of the year. Water temperatures must be within the range that synchronize the time of migration and emergence of fish and other aquatic organisms (Sweeney and Vannote 1978, Quinn and Tallman 1978).

Water Quantity

Adequate flow is critical at specific times in life cycles for spawning, rearing, and migration. The fish are adapted to natural variations in flow regimes, but are adversely affected by disturbances that alter natural flow cycles (Statzner et al. 1988).

Channel Characteristics

The most productive stream systems for mixed salmonid assemblages have gradients <5 percent, with a mix of constrained (ratio of valley width/active channel width <3) and unconstrained (ratio of valley width/active channel width >3) reaches containing a broad diversity and complexity of habitat features. Constrained reaches generally have fewer juvenile fish and less diverse assemblages than unconstrained areas. Constrained reaches are important, however, as sources of cool water (McSwain 1987), holding areas for adult salmonids, and are avenues of transport for sediment, wood, and other materials to unconstrained reaches. Unconstrained reaches are generally sites of high fish densities and contain large amounts of wood and sediment. They are also sites of sediment, organic material, and nutrient storage and processing (Stanford and Ward 1988). Good habitats maintain a balance between high quality pools, riffles, glides, and side channels. Cover features such as large woody debris, boulders, undercut banks, overhanging vegetation, deep water, and surface turbulence are abundant in good habitats. Substrates consist of a variety of particle sizes ranging from silts to boulders to accommodate the spawning and rearing needs of all species (Everest et al. 1987, Sullivan et al. 1987). Spawning gravels contain low percentages of fine sediments, generally <20 percent (see Bjornn and Reiser 1991). Channels are free of obstructions that interfere with the upstream or downstream migration of adult or juvenile salmonids.

Riparian Vegetation

Riparian vegetation regulates the exchange of nutrients and material from upland forests to stream (Swanson et al. 1982, Gregory et al. 1991). Forested watersheds contain large conifers or a mixture of large conifers and hardwoods in riparian zones along all streams throughout the watershed, including those not inhabited by fish (Naiman et al. 1992). Stream banks are vegetated with shrubs and other low-growing woody vegetation. Root systems in streambanks of the active channel stabilize the banks and allow development and maintenance of undercut banks and protect banks during large storm flows (Sedell and Beschta 1991).

Watershed Conditions

Upland portions of watersheds are well-vegetated, fairly stable, and free from chronic and accelerated sedimentation. Watersheds are free from disturbances that alter natural streamflow regimens, the quality of water emanating from uplands, and delivery of large wood to streams occupied by fish (Naiman et al. 1992). Unstable headwall areas are vegetated with large conifers, or a combination of conifers and hardwoods.

Current Fish Habitat Conditions

Fish habitat on National Forests and other lands within the range of the northern spotted owl is currently in less than optimal condition (Hicks et al. 1991, Bisson et al. 1992). Habitat has been lost or the quality reduced as consequence of past (Sedell and Luchessa 1982, Benner 1992, Bisson et al. 1992) and present land-management and regulatory activities (Bisson and Sedell 1984, Grant 1986, Salo and Cundy 1987, Meehan 1991). These trends represent the cumulative effects of these actions (Hicks et al. 1991).

The number of large pools (>6 ft deep and >25 yd² surface areas) in many streams tributary to the Columbia River, have decreased in the past 50 years (Sedell and Everest 1991). This was determined by comparing quantitative habitat surveys done recently in selected streams with surveys done by the Bureau of Fisheries between 1934 and 1941 (Rich 1948, Bryant 1949, Bryant and Parkhurst 1950, Parkhurst 1950a-c, Parkhurst et al. 1950). In the Washington and Oregon Cascade Mountains, the historical surveys were generally in late-successional Douglas-fir forests that had not been extensively roaded and harvested. The Bureau of Fisheries surveys are unique because they are the only long-term data set that quantifies fish habitat in a manner that is replicable over time; no other similar work is known to exist.

Over all, in the Washington Coastal and Cascades Provinces there has been a 58 percent reduction in the number of deep pools in resurveyed streams in Western Washington and Eastern Washington owl forests (Table 6-K-3). A similar trend was found in the Oregon Cascade Province; large pools decreased by 47 percent (Table 6-K-4). The primary reason for the loss of pools appears to be increased filling by sediments (Megahan 1982) and loss of pool forming structures such as boulders and large wood (Bryant 1980, Sullivan et al. 1987), and loss of channel sinuosity by channelization (Furness et al. 1991, and Benner 1992). In north coastal Oregon, streams on private lands experienced an 80 percent decline in large deep pools (Table 6-K-3).

The Wind River and the Lewis River in Washington were the exceptions to the trends. The upper western portion of the Wind River burned in the 1910's during the Yacolt Burn and its channels were also cleared and used for log drives augmented with floods released from a system of splash dams throughout the basin. The Wind River shows the recovery potential from large fire disturbances and logging activities experienced 50 years ago, plus the effects of Forest Service restoration efforts. The flood of 1964 probably helped return large wood and boulders into the upper tributaries of the Wind River basin. Reasons for the increase in large and deep pool frequency in the Lewis River is less clear.

The South Fork Umpqua was surveyed in 1937 by the Bureau of Commercial Fisheries on contract to the Forest Service. In 1990 seven tributaries were resurveyed by the Forest Service (J. Dose Umpqua National Forest). Two of these streams, Quartz and Castle Rock Creeks, serve as controls since little roading and logging has occurred within them and they have been entered within the last 10 years. The five other streams have been roaded and extensively logged from the early 1960's to the present. Stream widths have increased 50 to 110% in these streams. Stream temperature data from 1937 was taken on all of these streams at various dates in July and August. All of the streams indicated a similar temperature regime below 65°F. From 1980 to 1990 the

control stream Quartz Creek still exhibited a summer maximum water temperature regime below 65 F during the 60-day period July 1 to August 20. Where significant roading and timber harvest has taken place, maximum water temperature for the four other streams measured over the same 60 day summer period for the last 10 years has exceeded 65 F from 62-93% of the time. Numbers of pieces of large wood (>36" diameter and 50' long) reflect the same trends, being much higher in the "control" streams than these roaded and harvested basins.

There is an emerging consensus, however, that stream habitat has been simplified as a result of land-management and regulatory activities (Hicks et al. 1991, Bisson et al. 1992). Simplification of stream channels involves a decrease in the range and variability of stream flow velocities and depths (Kaufmann 1987), reductions in the amount of large wood and other structural elements (Bisson et al. 1987, Bilby and Ward 1991), elimination of physical and biological interactions between a stream and its floodplain (Naiman et al. 1992), and a decrease in the frequency and diversity of habitat types and substrates (Sullivan et al. 1987).

Causes and Implications of Habitat Degradation

Quantitative relationships between long-term trends in the abundance of fish and fish habitat and the effects of forest management practices have been difficult to establish (Hicks et al. 1991, Bisson et al. 1992). Because of inherent differences in stream size, storm magnitude, and geology, similar management practices may result in a different response (Hicks 1990). In addition, extended time periods may be required before the effects of land management are expressed in streams.

Despite the lack of strong quantitative relationships between forest management activities (and other activities as well), a primary consequence of these activities has been the simplification of fish habitat (Hicks et al. 1991, Bisson et al. 1992). In the Pacific Northwest, degraded fish habitats in managed watersheds in National Forests have resulted from many factors, most notably, the loss of large wood and loss of pools, increased water temperatures, a decrease in the diversity of substrates, and unstable streambanks (Hicks et al. 1991). Salo and Cundy (1987) and Meehan (1991) contain additional references detailing the link between effects of land-management activities and the condition of fish habitat. The consequence of these changes has been a reduction in the variety and range of habitats available to fish.

Large Wood

Large wood is essential for creating and maintaining good fish habitat in streams (Bisson et al. 1987). Large wood influences the routing and storage of sediment and wood, formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Swanson et al. 1982, Bisson et al. 1987). Refer to reviews by Bisson et al. (1987), Maser et al. (1989), and Naiman et al. (1992) for more detail on the role and function of large wood. Wood enters streams inhabited by fish either directly from the adjacent riparian zone or from upslope tributaries and hillslopes not accessible or inhabitable to fish.

Large wood may be reduced as a result of a variety of past and present-day timber harvesting associated activities. Buffer zones may have been inadequate because they have been too narrow, were vulnerable to windstorms and floods, harvest and salvage logging have been allowed in them, or they have not provided for long-term recruitment of large wood (Bryant 1980, Bisson et al. 1987). Additionally, sources of large wood for streams inhabited by fish may be eliminated by the absence of vegetative buffers in tributaries not inhabited by fish (Everest and Naiman 1954, Naiman et al. 1992). Debris flows and dam-break floods resulting from timber harvest activities may remove large wood from channels and riparian vegetation from streambanks (Benda and Zhang 1990, Swanston 1991).

The absence of wood in many streams may also be the legacy of past activities. Mandated clean-up activities removed wood from streams throughout the region of the northern spotted owl in the 1950's through 1970's (Narver 1971, Bisson and Sedell 1984). Earlier activities such as splash-damming networks storing water which was released to flood streams to transport logs also removed large amounts of wood from streams (Sedell and Luchessa 1982, Sedell and Duval 1986).

Habitat Complexity

Timber harvest activities can result in a decrease in the number and quality of pools (Sullivan et al. 1987). Wood is a major habitat forming element in streams. Reduction in the amount of wood in the channel, either from present or past activities, generally reduces pool quantity and quality (Bisson et al. 1987). Constricting naturally unconfined channels with bridge approaches or streamside roads (Furniss et al. 1991) so that stream meandering has been reduced, decreases pools formed by stream meanders that undercut banks. Influx of sediment from increased mass failures of roads (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1977, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Beschta 1978, Nolan and Marron 1985) and from increased mass failures following harvest on unstable slopes (O'Loughlin 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1977, Ziemer and Swanston 1977, Ketcheson and Froehlich 1978, Marion 1981, Grant and Wolff 1991, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985) can result in the loss of pools.

A primary factor influencing the diversity of stream fish communities is habitat complexity (Gorman and Karr 1978, Schlosser 1982, Angermeier and Karr 1984). More diverse habitats support more diverse communities. Habitat diversity can also mediate biotic interactions such as competition (Kalleberg 1958; Hartman 1965) and predation (Crowder and Cooper 1982; Schlosser 1988).

In Pacific Northwest streams, habitat simplification resulting from timber harvest activities leads to a decrease in the diversity of the anadromous salmonid complex (Bisson and Sedell 1984, Li et al. 1987, Hicks 1990, Reeves et al. in press). One species increases in abundance and dominance while others decrease. Holtby (1988) and Scrivener and Brownlee (1989) in British Columbia and Rutherford et al. (1987) in Oklahoma reported similar responses by fish communities in streams affected by timber harvest activities. Similar patterns have also been observed in streams altered by other anthropogenic activities such as agriculture (Schlosser 1982, Berkman and Rabini 1987) and urbanization (Leidy 1984, Scott et al. 1986).

Water Temperature

Increased water temperature in most cases can be traced to removal of shade-producing riparian vegetation along fish-bearing streams and along smaller tributary streams that supply cold water to fish bearing streams (Beschta et al. 1987, Bisson et al. 1988). Removal of streambank vegetation has resulted largely from timber harvest/salvage in riparian areas (Beschta et al. 1987).

Changes in the water temperature regime can affect the survival and production of anadromous salmonids, even when temperatures are below levels considered to be lethal. For example, Reeves et al. (1987) found that interspecific competition between reidside shiners (Richardsonius balteatus) and juvenile steelhead was influenced by water temperature; trout dominated at temperatures <20°C (68°F) and shiners at temperatures >20°C (68°F). In Carnation Creek, British Columbia, water temperatures during both summer and winter changed as a result of timber harvest activities. The consequence of this was accelerated growth and earlier migration of juveniles (Holtby 1988). However, survival of coho salmon to adults appeared to decrease because of the earlier time of ocean entry (Holtby 1988).

Sediments

Developing eggs and embryos of anadromous salmonids require relatively clean gravel (generally <20 percent fines) (Bjornn and Reiser 1991). Survival of developing eggs and alevins decreases as the levels of fines increase (Cederholm and Reid 1987, Chapman 1988, Scrivener and Brownlee 1989, Bjornn and Reiser 1991). Infilling of spawning gravel by fine sediments may result from accelerated erosion caused by road failures (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1977, Ketcheson and Froehlich 1978, Marion 1981, Furniss et al. 1991, Megahan 1992, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985), and slope failures following harvest on unstable slopes (O'Loughlin 1972, Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1977, Ziemer and Swanson 1977, Ketcheson and Froehlich 1978, Marion 1981, Megahan 1992, Scrivener and Brownlee 1989).

Rate of Habitat Recovery

Recent work by Hicks (1990) and Bilby and Ward (1991) suggest that habitat is slow to recover to pre-harvest levels of complexity. Schwartz (1991) found that cutthroat trout populations in streams with coho salmon failed to recover to pre-timber harvest levels 25 years after harvest. Gurtz and Wallace (1984) hypothesized that stream biota may not be able to recover from the effects of timber harvest. They believe that timber harvest has no analogue in the natural disturbance regime and therefore, organisms may not have evolved an appropriate response. Yount and Niemi (1990) classified timber harvest as a "press disturbance". This suggests a differential response of species to the disturbance and the system may not recover to pre-disturbance states, due to the loss or alteration of functions and processes affecting the system.

Previous studies of the impact of timber harvest have been focused at relatively small spatial scales, generally confined to stream reaches having a length of less than 100 m (e.g., Murphy et al. 1981, Hawkins et al. 1983, Carlson et al. 1990). Streams are tightly coupled systems, with downstream areas highly influenced by events upstream (Vannote et al. 1980). Therefore,

to understand fully the effect of timber harvest and other human activities on fish communities, a broader spatial context such as the basin or subbasin scale may be required. Few large-scale studies have been conducted. The Alsea Watershed Study in Oregon (Hall et al. 1987) and the study on Carnation Creek in British Columbia (Holtby 1988; Scrivener and Brownlee 1989), focused on the fish species separately. Such studies have not considered community level aspects.

Alteration of ecological processes and environmental conditions may affect several levels of ecological organization. Individual and population responses may vary depending on the magnitude and duration of the impact, species-specific requirements (Kelly and Harwell 1990, Yount and Niemi 1990), and the presence of refugia (Sedell et al. 1990). Because of variability in response by individuals and populations, members of a community are unlikely to exhibit a uniform response to disturbance or environmental alteration. The effect of disturbance on communities depends, in part, on the combined effect on both individuals and populations as well as the extent to which processes that influence the structure and composition of communities are altered (e.g., Reeves et al. 1987, Baltz et al 1982).

CONSERVATION STRATEGY FOR FISH HABITAT IN NORTHERN SPOTTED OWL FORESTS

In keeping with the principles and information presented in the previous sections, we have developed a conservation strategy for fisheries habitat on Forest Service lands in the owl region. Given current levels of information and understanding, the uncertainty inherent in natural, watershed processes, and the current perilous state of many native stocks of salmon and steelhead (Nehlsen et al. 1991, Higgins et al. 1992), a more conservative approach to management of fisheries resources on Federal lands is both warranted and prudent.

This conservation strategy is one of six draft alternatives developed to improve fish habitats in National Forests under the Forest Service's Pacific Salmon and Steelhead Habitat Conservation process. Our strategy was rated as having a high likelihood of restoring/maintaining ecologically functional streams and riparian zones and ensuring habitats and environmental conditions for inclusion in this report of the Scientific Analysis Team. The development of the Forest Service's Pacific Salmon and Steelhead Management (PACFish) direction will not be completed until April 1993. During the interval between this document and completion of the PACFish effort other alternatives will continue to be assessed and evaluated.

In this section the scientific rationale for the proposed conservation strategy is set forth and the specific elements of that strategy are described.

Rationale and Basis for Conservation Strategy

The approach we have taken in developing our recommended conservation strategy for fish differs somewhat from comparable strategies for other organisms. Reasons for this rest with both the unique biological requirements of, and scientific uncertainties associated with, anadromous fish. Unlike other organisms whose habitat requirements may be well-defined and understood, anadromous fish occupy a range of habitats over large areas because of their life histories, environmental conditions, and interspecific interactions (Bisson et al. 1992). Over the course of its life, an individual fish may hatch in a headwater stream, rear in a lower-gradient alluvial reach, pass through an estuary on the way to the ocean, only to reoccupy many of the same habitats upon returning to spawn. The freshwater component of their life histories thus play out over a grand scale that may span several hundred miles of river network set within a landscape of many thousand square miles. Any conservation strategy to protect and restore fish runs must take this scale into account.

A second factor is that the current level of scientific understanding of fish habitat relationships does not permit us to define specific habitat requirements for fish throughout their life cycle at the watershed level. The general habitat needs of fish are well known (Bjornn and Reiser 1991) (i.e. deep resting pools, cover, certain temperature ranges, clean gravels for spawning). However, we cannot specify how these habitats and conditions should be distributed through time and space to provide for fish needs. Our understanding of fish habitat requirements is largely based on laboratory and site-specific studies that typically examine a single requirement for a single species at one point in its life cycle at a time. In natural watersheds, however, multiple species of different ages interact with multiple habitat

elements in complex ways. This interaction occurs within a landscape where the quality and distribution of habitat elements changes with time in relation to disturbance processes and land use-imposed changes on streams and riparian zones.

Given the need to address fish habitat at a broad landscape scale coupled with the uncertainties associated with specifying how habitat needs to be distributed over a watershed through time, we have not adopted a strategy of delineating specific watersheds with explicit standards for habitat elements. Rather, we have focused our efforts on developing a landscape-wide strategy that seeks to retain, restore, and protect those processes and landforms which contribute habitat elements to streams and promote good habitat conditions. We have attempted to develop a conservation strategy that is aimed at restoring/maintaining the ecological health of watersheds (Karr et al. 1986, Karr 1991, Naiman et al. 1992). At the heart of this approach is recognizing that fish have evolved within a dynamic environment that has been constantly influenced and changed by geomorphic and ecologic disturbances. Good stewardship of fisheries resources requires that our land use activities not alter this disturbance regime beyond the range of conditions to which these organisms have become adapted.

The disturbance regime of watersheds in the Pacific Northwest includes both geomorphic and non-geomorphic processes. Important geomorphic processes include mass movements (i.e. debris slides, debris flows, deep-seated landslides), peak streamflows, bank erosion, dam-break floods, and ice rafting (Swanston 1991). Non-geomorphic processes include fire, windstorms, and vegetation mortality due to disease and insects. These processes influence the input rate, quantity, quality, and movement of water, sediment, nutrients and wood through streams. It is the interaction of these elements with the channel and surrounding riparian zone that determines the abundance and quality of fish habitat within watersheds. Habitat degradation occurs where a change in the character of disturbance processes -- that is, their frequency, magnitude, severity, or legacies of physical structure -- pushes this interaction outside the range of conditions to which fish have evolved. Most of the habitat degradation attributable to human activities is due to increasing the frequency or magnitude of disturbances (for example, landslides and debris flows [Swanston and Swanson 1976]), or decreasing the physical legacy of disturbances (for example, by reducing the quantity or quality of large woody debris delivered to channels by landslides and debris flows).

Our strategy is thus predicated on the principle of maintaining as close to a 'natural' disturbance regime, as measured by the aforementioned attributes, as is possible within watersheds and landscapes, many of which have already been altered by human activities. We recognize that disturbances are essential to maintain good fish habitat; in many cases the elements that physically create this habitat (i.e. boulders, large wood, gravel) are contributed to streams by episodic events. We wish to ensure, however, that the rate at which these disturbances occur does not significantly increase due to human activities, and that when these disturbances do occur, they retain all of the elements necessary to create high quality habitat.

Doing this requires several approaches. Land-use activities need to be limited or excluded in parts of the landscape known to be prone to geomorphic disturbances, such as mass movements or bank erosion. The distribution of land

use activities, such as clearcuts or roads, needs to be analyzed to ensure that peak streamflows are not being increased. Headwater riparian zones need to be protected, so that when debris slides and flows occur, they entrain large wood and boulders necessary for creating habitat further downstream. Riparian zones along larger channels need protection to limit bank erosion due to trampling, grazing, and compaction, to ensure an adequate and continuous supply of large wood to channels, to provide shade and microclimate protection.

The approach we have taken is designed to accomplish these objectives. It needs to be emphasized, however, that it will require time for this strategy to work. Because it is based on natural disturbance processes, it may require timescales of decades to over a century to accomplish all of its objectives. Significant improvements in fish habitat, however, can be expected on the timescale of 10 to 20 years. This is particularly true since this approach seeks to maintain and restore habitat over broad landscapes as opposed to individual projects or small watersheds. We believe that if this approach is conscientiously implemented and applied, it will provide protection for fisheries resources in perpetuity and restore currently degraded habitats.

Components of the Fish Habitat Conservation Strategy

The Fish Habitat Conservation Strategy is designed to conserve and restore habitat for threatened stocks of anadromous salmonids in the owl Forests. It rests on four critical components: (1) identifying a landscape-level system of watershed refugia located on Forest Service lands throughout the owl region; (2) establishing watershed protection areas for individual watersheds where land use activities are restricted to those which either directly benefit or do not affect fish habitat; (3) implementing watershed analysis as an explicit level of planning designed to evaluate geomorphic and ecologic processes operating in specific watersheds, identify boundaries of watershed protection areas, and provide a blueprint for restoration measures; and (4) initiating comprehensive watershed restoration measures on watersheds, with priority given to those having the greatest potential to provide high quality fish habitat. Each element addresses a critical aspect for maintaining and restoring fish habitat and ecological functions in streams. They are designed to act as a comprehensive package and will not achieve desired results if implemented alone or in some limited combination.

Component 1: Designated Lands Providing Habitat Protection

Refugia or designated areas providing high quality habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Refugia are habitats or environmental factors that convey protection to biotic communities at different temporal and spatial scales. Examples of aquatic refugia range from clean gravels at the particle scale, to well-vegetated floodplains and side channels at the channel reach scale, to the condition of the whole watershed at the watershed scale. In a review of case histories of recovery of aquatic systems following disturbance, Yount and Niemi (1990) and Niemi et al. (1990) found considerable evidence that the existence of spatial refugia--undisturbed habitats providing a source of colonists to adjacent areas--was critical to enable recovery of degraded systems. In stream systems where disturbance was widespread and no accessible refugia remained, biological recovery was delayed or entirely precluded.

At a minimum, refugia need to be considered at a watershed scale, rather than as fragmented areas of suitable habitat. Sedell et al. (1990) and Moyle and Sato (1991) discuss several kinds of riverine and hyporheic habitats that can act as refugia, and provide examples of how they may function in the recovery of populations from natural catastrophe and anthropogenic disturbance. Sedell et al. (1990) argue that refugia at the scale of reaches or larger tend to be more resistant and resilient to a variety of disturbances. Moyle and Sato (1991) argue that to recover species, refugia should be focused at the watershed scale. Management and restoration strategies that focus on reaches or small segments of a watershed fail to consider the connectivity of stream ecosystems. Naiman et al. (1992), Sheldon (1988), and Williams et al. (1989) noted that past attempts to recover fish populations have been unsuccessful because of the failure to approach the problem from a basin perspective.

Even a system of isolated watersheds acting as refugia may not be sufficient for a regional conservation strategy. Stocks at risk are distributed across the entire range of the owl forests. Over its life history an individual fish will travel through and occupy habitats in a range of watersheds of different sizes. Poor habitat conditions at any point of this journey will reduce chances of survival. Sheldon (1988) believed that 3rd- to 5th-order watersheds should be the cornerstone of watershed-level recovery efforts for fish in general. This is likely an appropriate minimum size range for anadromous fish. However, planning for habitat protection and restoration needs to include watersheds at the scale of about 100,000 acres (e.g., South Fork Umpqua River).

For these reasons, we have adopted a landscape or bio-regional perspective as the basis of a watershed refugia system that provides for salmonid stocks at risk throughout the owl Forests. Under this strategy, all Forest lands and streams within the owl region are functioning as refugia. These include not only watersheds and streams that contain high quality habitat for fish but also streams and tributaries that contribute key habitat elements (i.e. boulders, large wood, cool water) but may not actually support fish. It also includes currently degraded streams that do not contain high quality habitat but which could do so if proper restoration measures (Component 4) were adopted.

Component 2: Watershed Protection Areas (WPAs)

For Forest Service streams and lands to function as refugia, special considerations need to apply to those parts of watersheds which directly contribute to creating or maintaining aquatic habitat. Watershed Protection Areas (WPAs) are portions of watersheds where riparian-dependent resources receive primary emphasis and where special Standards and Guidelines apply. WPAs encompass those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect streams, stream processes, and fish habitats. WPAs include not only the more common Forest Plan-designated riparian management zones (RMZs) or streamside management zones (SMZs) adjacent to rivers, streams, springs, seeps, wetlands, and marshes but also includes primary source areas for wood and sediment such as landslides and landslide-prone slopes in headwater areas and along streams. WPAs generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic processes (Figure 6-K-2).

Establishment of watershed protection areas will confer benefits to riparian dependent and associated species other than fish. It will enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas. Many amphibians depend on wood created habitat in headwater streams (Bury et al. 1991). Improved travel and dispersal corridors for numerous terrestrial animals and plants and a greater connectivity of the watershed will also result from delineation of watershed protection areas (Gregory et al. 1991).

The boundaries of a WPA are determined by watershed analysis (Component 3). We have established a set of interim widths of WPAs to guide application of Standards and Guidelines until watershed analysis has been completed. The widths are intentionally conservative to provide a full measure of fish habitat and riparian protection until this analysis can be completed.

Interim Widths of WPAs for Different Water Bodies

Interim Widths of WPAs: Interim widths of WPAs vary with stream type, defined as: 1) fish-bearing streams; 2) non-fish-bearing streams; and 3) water-bodies and wetlands; and 4) other perennial, intermittent, or ephemeral streams that individually may have little effect on fish habitat, but are nonetheless collectively essential for maintaining processes that affect fish habitat. WPAs also include hydrologically, geomorphologically, and ecologically significant areas such as landslides and landslide-prone areas, springs, seeps, marshes, and wetlands.

Several criteria were used to define interim widths of WPAs for each stream type. Of concern are how the various geomorphic and ecologic functions provided by riparian areas change with distance from the stream and stream size. Key riparian processes considered in developing widths included sources of: input of large and small woody debris and litter, shading, and buffering streams from the effects of strong winds and other microclimatic fluctuations (Gregory et al, 1991). Also considered were the roles of vegetated and undisturbed floodplains in maintaining functioning side channels (used by fish for overwintering and refugia during peak flows) and hyporheic zones (which may supply cool or nutrient-rich groundwater during summer months).

Approximate widths associated with each stream type are drawn from the scientific literature quantifying how these functions vary in relation to distance from the stream. Several studies have documented, for example, that the source of most woody debris in the stream is within one tree height or approximately 150 feet for mature Douglas-fir forests (McDade et al, 1990; Van Sickle and Gregory, 1990). Microclimatic effects associated with forest edges penetrate far deeper into the interior of forests or riparian zones. Influence of the edge on air temperature ranged from 180 to 360 feet (1 to 2 tree heights) in upland Douglas-fir forests, while high wind velocities penetrated at least 5 tree heights (Chen et al, in press). Higher values (up to 8 tree heights) have also been reported (Raynor, 1971). While these values were measured for upland forests, they represent good estimates for edge effects into riparian zones as well. These distances influence the potential for blowdown of riparian zones and argue in favor of extending WPA widths beyond the zone of direct woody debris input to protect the riparian area against disturbance. Microclimatic gradients may also play an important role in determining suitability of habitat for other riparian-dependent species.

We believe that the character of any conservation program for maintaining and restoring anadromous fish habitat must be conservative to have a high probability of being successful. A program of this nature is necessitated by the large number of stocks at risk (112) and the overall poor conditions of habitat and aquatic ecosystems on National Forests in the range of the northern spotted owl. We believe that it is prudent and justified to require WPA widths to incorporate areas larger than traditional riparian management areas, at least in the interim until a watershed analysis is completed. Therefore, interim widths incorporate riparian areas and their zone of influence (Gregory et al. 1991).

Maintaining the connectivity of all parts of the aquatic ecosystem is necessary for healthy watersheds and good fish habitat (Naiman et al. 1992). First and 2nd-order streams, which include the permanently flowing non-fish bearing streams and seasonally flowing or intermittent streams described previously, may represent over 70 percent of the cumulative channel length in mountain watersheds in the Pacific Northwest (Benda et al. 1992). These streams are sources of water, nutrients, wood and other vegetative material for streams inhabited by fish (Swanson et al. 1985, Benda 1990, Vannote et al. 1980). Decoupling the stream network can result in the disruption and loss of functions and processes necessary for creating and maintaining fish habitat. The WPA widths specified for the different stream and wetland types were developed to maintain connections in watersheds that are currently in good shape and to initiate recovery of the connections in degraded areas.

Interim widths of WPAs are reduced as stream size decreases to account for the more limited floodplain and riparian areas around smaller streams and the greater input of wood from adjacent steep hillslopes.

Based on these criteria, we identify four types of streams or water-bodies and define interim widths of WPAs for each.

Fish-bearing Streams: The WPA consists of the stream and the area on either side of the stream extending from the edge of the active stream channel to the top of the inner gorge, or to the outer edge of the 100-year floodplain, or to the outer edge of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet horizontal distance (600 feet, including both sides of the stream channel), whichever is greatest.

The first 200 feet of the WPA recognizes the adjacent land as a source of shade, large wood, detritus, and water of favorable temperature. The last 100 feet will serve to maintain microclimate and to protect the first 200 feet from fire and wind damage and help ensure that the integrity of the functional WPA survives over the long-term to benefit fish habitat and riparian dependent species.

Permanently Flowing Non-fish-bearing Streams: The WPA consists of the stream and the area on either side of the stream extending from the edge of the active stream channel to the top of the inner gorge, or to the outer edge of the 100-year floodplain, or to the outer edge of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet horizontal distance (300 feet, including both sides of the stream channel), whichever is greatest.

Lakes, Ponds, Reservoirs, and Wetlands Greater Than One Acre: The WPA consists of the body of water or wetland and the area from the edge of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet horizontal distance for lakes, ponds, and wetlands greater than one acre, and from the edge of the maximum pool elevation of reservoirs, whichever is greatest.

Seasonally Flowing or Intermittent or Streams, Wetlands Less Than One Acre, Landslides, and Landslide-Prone Areas: This category applies to riparian ecosystems with high variability in size and site-specific characteristics. The WPA consists of the stream channel or wetland and the area from the edge of the stream channel or wetland to the top of the inner gorge, or to the outer edge of the riparian vegetation, or to the extent of landslides or landslide-prone areas, or to a distance equal to the height of one site-potential tree, or 100 feet horizontal distance (200 feet, including both sides of the channel), whichever is greatest.

We emphasize that WPA widths for all groups of streams are interim until a watershed analysis has been completed. If watershed analysis should indicate that, because of the characteristics of a given site, narrower or wider WPAs would provide the better function than the interim WPA, then the WPA width could be changed, and any allowable management activities would be adjusted to reflect these new WPA dimensions. **The only criterion for removing or adding an area is the function of that area in relation to maintaining/restoring processes that affect fish habitats.**

Figure 6-K-2 illustrates how a WPA might appear in an example schematic watershed. This watershed is characterized by a stream drainage network that consists of a major fish-bearing stream, several fish-bearing tributaries, and some non-fish bearing intermittent tributaries. The watershed also contains a marshy area near the watershed outlet, a large, inactive landslide, and many landslide-prone areas in steep terrain near the watershed boundary. The WPA extends around and includes all these features.

Standards and Guidelines for WPAs: Once the WPA width is established, either based on interim widths or watershed analysis, then land management activities allowed in the WPA will be determined by Standards and Guidelines for managing WPAs. In general, these standards and guidelines prohibit activities in WPAs that are not designed specifically to improve the structure and function of the WPA and benefit fish habitat.

WPA standards and guidelines are detailed in the following section of this appendix. They generally prohibit scheduled timber harvest, salvage cutting, and the location of landings, skidtrails, and skyline corridors in WPAs; restrict road construction in unstable terrain; specify improved road drainage systems of future roads in WPAs, upgraded drainage systems of existing roads in WPAs, and road maintenance during and after storms; and improved management of grazing, recreation, and mining activities in WPAs.

These standards and guidelines for WPAs will guide management activities within WPAs until completion of a watershed analysis. The watershed analysis will refine these standards and guidelines to better meet the goals for riparian areas. The objective of enhancing riparian and fisheries values within WPAs

must be paramount, however, in any modification of these standards and guidelines.

Component 3: Watershed Analysis

Watershed analysis is a systematic procedure for characterizing watershed history, processes, landforms, and conditions to meet specific objectives. It is a prerequisite for determining which processes and parts of the landscape contribute directly to fisheries and riparian habitat, and is essential for defining ecologically sensitive boundaries for Watershed Protection Areas (WPAs). Watershed analysis forms the basis for evaluating cumulative watershed effects, defining watershed restoration goals and objectives, implementing restoration strategies, and monitoring the results or effectiveness of all these measures. Watershed analysis employs the perspectives and tools of multiple disciplines, especially geomorphology, hydrology, geology, fish and terrestrial ecology, and soil science. It is the framework for understanding and implementing land use activities within a geomorphic context.

Watershed analysis consists of a sequence of activities designed to identify and interpret the full suite of disturbance processes operating in a specific landscape. The appropriate spatial scale for this type of analysis varies somewhat from region to region, but is approximately the size of 5th-order watersheds (5,000 to 30,000 acres in most owl forests). Elements in a watershed analysis include:

- 1) Characterizing the biogeoclimatic context of a specific watershed, including interpreting its hydrologic, geomorphic, and ecologic role with respect to neighboring watersheds.
- 2) Determining the type, areal extent, frequency, and severity of watershed disturbance processes, including mass movements, fire, peak and low streamflows, surface erosion, and other processes affecting the flow of water, sediment, wood, nutrients, or energy through a watershed.
- 3) Determining distribution and abundance of fish and other riparian dependent species and evaluating life history and habitat requirements and limiting factors.
- 4) Identifying parts of the landscape, including hillslopes and channels, that are either sensitive to specific disturbance processes or critical from the standpoint of beneficial uses or key species or populations.
- 5) Interpreting watershed history, including the effects of previous natural disturbances and land use activities on watershed processes.
- 6) Using all of this information to establish ecologically sensitive boundaries of Watershed Protection Areas.
- 7) Refining Standards and Guidelines to fit specific landscape conditions and limitations.
- 8) Designing approaches to evaluate and monitor the effectiveness and reliability of the analysis procedure and identified protection areas.

- 9) Identifying restoration objectives and strategies and developing a blueprint for restoration activities.

Tools used in watershed analysis include historical data, including aerial photographs, streamflow records, mass movement inventories, and land use histories; topographic, geologic, and soil maps; field reconnaissance of hillslopes and channels; field surveys of fish habitat; and computer models of hydrologic, geomorphic, and ecologic processes. Products include maps of protection areas, results of modelling exercises, and a record of assumptions, caveats, and uncertainties associated with the analysis.

The concept of watershed analysis is not new, and many National Forests have been conducting planning exercises which utilize elements of watershed analysis. However, few, if any, National Forests conduct watershed analysis as we have described it. Furthermore, there is little consistency in objectives, methods, or results from Forest to Forest. Current efforts typically address only limited aspects of the problem, for example identifying unstable ground or scheduling harvest to minimize watershed areas in cutover or young stands at any time. Little attempt is made to identify current conditions, results of past practices, or limiting factors for fish or other riparian dependent organisms. Because the scale of watershed analysis falls between the scales of Forest and Project Planning, it typically does not carry with it the legal mandate to require implementation of its findings.

In recent years, formal watershed analysis has begun to come to the forefront of forest land management and is now required by law on state and private forest lands in Washington (Washington State Forest Practice Board 1992). Within the Forest Service, an example of watershed analysis is the Draft Environmental Impact Statement for the Elk River Wild and Scenic River Plan (Siskiyou National Forest 1992). An across-the-board requirement for watershed analysis does not exist, however, within the Forest Service.

We recognize that implementing watershed analysis systematically and consistently will require major changes in the ways that the Forest Service currently manage the land. To assist with this transition, and to allow for planning and forest management activities to proceed in the face of the large task of performing this analysis on all Forest watersheds in the owl region, we have identified two levels of watershed analysis. **Level I analysis** is a coarse filter designed to identify priority watersheds, determine critical processes operating in those watersheds, and provide a preliminary estimate of boundaries for WPAs. Some forest management activities within WPA may be allowed from Level I analysis alone if they clearly would not affect processes and elements contributing to aquatic habitat and are compatible with the Standards and Guidelines for WPAs. Level I analysis would commonly be conducted using aerial photographs, map data, and existing field surveys. **Level II analysis** is the more rigorous and detailed analysis to identify current status and limiting factors for fish and other organisms, identify final boundaries of WPAs, refine Standards and Guidelines to fit specific landscape conditions and limitations, and identify and prioritize restoration strategies and objectives. Level II analysis would be performed using sequential aerial photos, map/GIS data, existing and new field surveys, and computer simulations as necessary.

Component 4: Watershed restoration

Watershed restoration is the fourth component of the conservation strategy. Watershed restoration addresses improving the current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic resources. As discussed under Component 1, watersheds that serve as refugia are crucial for maintaining and recovering habitat of potentially threatened anadromous salmonid stocks. These refugia should include areas that currently have good habitat as well as areas of degraded habitat. Areas presently in good condition would serve as anchors for the potential recovery of depressed stocks. Wilderness areas, National Recreation Areas and other specially designated areas currently contain much of the high quality fish habitat on National Forest lands, and are the areas that currently provide habitat for stocks and species at risk. While these areas would be the anchor of a watershed refugia system, additional watersheds that currently have low quality habitat would be future sources of good habitat with the implementation of a comprehensive restoration program.

A network of key watersheds throughout the northern spotted owl forests which fit the criteria of good habitat, threatened fish species and stocks, and restoration potential was identified by Johnson et al. (1991). Forest Service biologists in Region 5 have deleted and added watersheds since that list was published (Figure 6-K-3). Figures 6-K-4 and 6-K-5 are from Johnson et al. (1991) and illustrate the network of key watersheds for Oregon and Washington.

To be effective in restoring salmonid habitats, a restoration strategy needs to incorporate:

- A regional strategy that looks across landscapes and ownerships to identify where restoration efforts are likely to be most effective;
- An explicit recognition of how differences in physiography and specific impacts on stream systems will require different restoration measures;
- A detailed watershed analysis to adapt restoration strategies to specific landscapes, taking into account unique watershed histories, conditions, and resources;
- A specific set of objectives for each watershed;
- An explicit role for research and monitoring in defining and refining restoration objectives and tracking the effectiveness of restoration measures.

These elements are discussed below:

Regional strategy for identifying key watersheds: Priority watersheds for restoration should be those currently providing habitat for stocks or species at risk, but may also include areas with high restoration potential. Watersheds should be well distributed throughout the region or area of concern with a minimum size range of 3rd- to 5th-order drainages. Key watersheds should consist of watersheds currently in high quality habitat and watersheds with recognized opportunity to be restored to high quality habitat through management actions. The "restoration" objective watersheds should be located near the "currently high quality" watersheds so that recolonization of fish to currently degraded areas can occur as conditions improve.

Much of the work in identifying key watersheds has already been done for the westside forests (Figures 6-K-3 through 6-K-5). The Scientific Panel on Late Successional Ecosystems (Johnson et al. 1991) using Forest Service scientists and resource specialists identified a network of watershed reserves on federal lands to improve protection of key populations of imperiled anadromous fish in parts of the Pacific Northwest. The Oregon Chapter of the American Fisheries Society is near to completing an extensive inventory to identify habitat refugia and "critical areas" across the state. Areas identified in this survey include intact whole watersheds harboring high aquatic diversity, watersheds contributing critically to downstream water quality, stream reaches having a relatively high degree of natural habitat complexity and native species diversity, and estuaries, lakes, and wetland complexes that are least disturbed in their region and least affected by introduced species.

Distinguish physiographic regions: Physiographic regions vary considerably in both their intrinsic sensitivities to watershed disturbance and in the specific impacts involved. Restoration strategies need to be tailored to the specific processes and conditions occurring in different regions. Watershed analysis is the key to developing landscape-specific strategies.

Detailed watershed analysis: Prior to any restoration activities, the watershed analysis we have described in Component 3 is needed to identify: key watershed disturbance processes and where they occur on the landscape; current conditions of hillslopes and channels; status of aquatic communities including threatened and endangered populations; limiting factors for riparian ecosystems; inventory of past land use practices, including roads, clearcuts, grazing allotments, mining impacts.

Define restoration objectives and strategies: The watershed analysis will provide a spatially explicit set of objectives for restoration activities. These objectives establish the framework for restoration work, including what measures are needed, where they are to be carried out, which techniques need to be used; what sequence of actions should be planned; and how the work is to be accomplished.

Research and monitoring included in restoration plans: There is limited experience and few successes in restoring watersheds and ecosystems. To learn from our actions, a research perspective needs to be utilized and monitoring built directly into the restoration strategy. Restoration needs to be based on scientifically credible concepts of how watersheds and their biota function. A research perspective considers replication, stratification, statistical design, sampling protocols, and responsibility for data management and analysis.

Summary

This Conservation Strategy for Fish Habitat in the owl Forests represents a significant attempt to develop a long-range program that maintains the existing balance of processes, functions, and habitat elements in intact aquatic and riparian ecosystems, and initiates the recovery of processes and functions in degraded systems. We believe that if this strategy is implemented and adhered to, in conjunction with other protection measures outlined in this plan, it will lead to a functioning landscape that buffers and absorbs disturbances to streams rather than amplifies them.

We reiterate that this fish habitat conservation strategy will not, by itself, prevent the demise of potential threatened fish stocks. Decline of freshwater habitat and disruption of ecological processes and functions are only one of the factors responsible for the decline of anadromous fish stocks. We believe that this strategy in combination with the other mitigations of the Scientific Analysis Team Report will accommodate the naturally dynamic nature of stream and riparian systems in the owl forests, facilitate the recovery of degraded systems to more productive states, maintain options for future management, and sustain fish habitat and ecologically necessary riparian and watershed functions until additional knowledge allows us to implement new management measures.

STANDARDS AND GUIDELINES FOR MANAGING WATERSHED
PROTECTION AREAS (WPAs)

Developing prescriptions for improving anadromous fish habitats includes formulating standards and guidelines that address the types of management activities that are allowed in WPAs. In general, these standards and guidelines prohibit activities in WPAs that are not designed specifically to improve the structure and function of the WPA and benefit fish habitat. Management activities in WPAs must contribute to improvement/maintenance of watershed and aquatic habitat conditions as described in the riparian condition goals. When activities do not contribute to, or will detract from, meeting condition goals, those activities will be modified, rescheduled, or discontinued.

These standards and guidelines for WPAs will guide management activities within WPAs until completion of a watershed analysis. The watershed analysis will refine these standards and guidelines to better meet the riparian condition goals. The objective of enhancing riparian and fisheries values within WPAs must be paramount, however, in any modification of these standards and guidelines.

The standards and guidelines that follow are not all-inclusive. Watershed and riparian area management on National Forest System lands is guided by a variety of direction, including BMPs, Forest Plans, Forest Service manuals and handbooks, and other plans and directives. For the lands contained within the WPA, these standards and guidelines supersede other direction, unless the conflicting standard or direction affords greater protection to riparian and fisheries values and better fosters attainment of the riparian condition goals.

Timber Management

- TM-1. Prohibit scheduled timber harvest, including fuelwood cutting, in WPAs. Allow unscheduled harvest only as described in TM-2 and TM-3.
- TM-2. Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow unscheduled timber harvest (salvage and fuelwood cutting) to attain riparian condition goals. Remove salvage trees only when site-specific analysis by an interdisciplinary team determines that present and future woody debris needs are met and other riparian condition goals are not adversely affected.
- TM-3. Design silvicultural prescriptions for WPAs and allow unscheduled harvest to control stocking, reestablish and culture stands, and acquire desired vegetation characteristics needed to attain riparian condition goals.

Roads Management

- RF-1. Keep road and landing construction in WPAs to a minimum. No new roads or landings will be constructed in WPAs until a watershed, transportation, and geotechnical analysis is completed. The

appropriate standards for road construction, maintenance, and operations will be developed from this analysis to ensure that riparian condition goals are met. Valley bottom and mid-slope road locations may be used only when this analysis indicates that roads can be constructed and maintained in these locations and meet riparian condition goals.

- RF-2. Design, construct, maintain, and operate all roads on National Forest System lands (including those operated by others) in a manner consistent with the planned uses and with meeting riparian condition goals.
- RF-3. Inventory and evaluate all existing roads in WPAs. Through an interdisciplinary team review process, determine the influence of each road upon the riparian condition goals. Roads that are determined to pose a substantial risk to riparian conditions will be improved or obliterated. Priority will be based on the potential impact to riparian resources, the ecological value of the riparian resources affected, and the need for each road. Roads not needed for future management activities will be closed and obliterated. All obliteration work will meet riparian condition goals and provide for adequate long-term drainage and stability.
- RF-4. Complete and maintain Road Management Objectives that meet riparian condition goals for each road needed for management activities.
- RF-5. Conduct watershed analysis to identify existing culverts that present a risk to meeting watershed condition goals. Culverts determined to pose a substantial risk to riparian conditions will be improved to accommodate a 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure. In locations determined to have a high potential for failure, the roadway surface and fills will be hardened to further lessen the chance of roadway failure or severe erosion should the crossing over-top.
- RF-6. Design and construct new stream crossings to accommodate the 100-year flood, including associated bedload and debris.
- RF-7. Locate, design, construct, maintain, and operate roads to minimize disruption to natural hydrologic flow paths. This includes road-related activities that would divert streamflow and/or interrupt surface or subsurface flow paths.
- RF-8. Apply design, construction, and maintenance procedures to limit sediment delivery to streams from the road surface. Outsloping of the roadway surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where

outsloping is infeasible. Route road drainage away from potentially unstable channels and hillslopes.

- RF-9. Construct, reconstruct, and maintain all road crossings of existing and historic fish bearing streams to provide for fish passage.
- RF-10. Develop and implement a Road Management Plan that will meet the riparian condition goals. As a minimum, this plan shall include:
- a. Conduct post-storm inspections of roads known to contribute to degrading the riparian resources. Perform timely maintenance if deficiencies are found.
 - b. Inspect and maintain all roads providing for passenger car traffic (maintenance levels 3-5) during storms having a predicted potential to cause problems.
 - c. Inspect roads providing for high-clearance vehicle use (maintenance level 2) and those closed, but needed in the future (maintenance level 1), following each storm having a runoff event with a recurrence interval of 1 year or greater. Correct deficiencies that would contribute to degrading riparian resources before the next storm.
 - d. During annual road maintenance, give high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.
 - e. All road maintenance activities will meet standards that provide for the protection or improvement of the riparian resources.
 - f. During extreme wet periods, exclude traffic from roads that do not meet all-weather standards (maintenance levels 3-5).
- RF-11. Designate sites to be used as water drafting locations during project-level analysis, or as part of road maintenance for fire management planning. Do not locate drafting sites where instream flows could become limiting to aquatic organisms. During periods of low flow, examine the drafting site to determine if water can continue to be extracted from that site. Design, construct, and maintain water drafting sites so they will not destabilize stream channels or contribute sediment to streams.
- RF-12. Prohibit sidecasting of loose material in WPAs during construction or maintenance activities.

Grazing Management

- GM-1. Establish vegetation reference areas to measure potential site productivity and stream channel morphology that would exist in the absence of grazing, as well as to monitor the condition of the ecosystem. Reference areas are to be in locations representative of the vegetative community and stream channel

types to be managed. Reference areas may include exclusion plots, larger exclosures, or sites with a low disturbance history.

- GM-2. Manage grazing within WPAs in accordance with the riparian condition goals and to achieve good fish habitat conditions.
- GM-3. Conduct systematic monitoring of vegetation status for riparian condition using standardized practices and procedures to determine the influences of grazing on riparian ecosystems.
- GM-4. If monitoring of grazing use indicates that riparian condition goals are not being met, promptly adjust grazing practices to eliminate the adverse effects to the riparian resources. If adjusting practices is not effective, eliminate grazing until it is determined that grazing can be reestablished in a manner that would allow attainment of the riparian condition goals.
- GM-5. Locate new livestock handling facilities outside WPAs. For existing livestock handling facilities inside the WPA that are essential to proper management, apply standards to meet riparian condition goals and to mitigate damage to riparian resources. Where these goals cannot be met, require relocation of facilities.

Recreation Management

- RM-1. Develop recreation facilities, including trails, within WPAs only when such development is compatible with the attainment of riparian condition goals.
- RM-2. Monitor the impacts of dispersed or developed recreation in WPAs. When riparian condition goals are not being met, reduce impacts by methods including education, use limits, more intensive maintenance, facility modification, and/or area closures. For example, harassment of fish during spawning or low water can be reduced by closing access roads or campgrounds during critical periods or education of users.

Minerals Management

- MM-1. For operations in WPAs, ensure that adequate reclamation plans and bonds are included in approved plans of operation. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring of disturbed areas to near pre-mining topography; isolation and neutralization or removal of toxic or potentially toxic materials; salvage and replacement of topsoil; and seedbed preparation and revegetation to meet riparian condition goals.
- MM-2. Avoid locating permanent structures or support facilities within WPAs. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to minimize damage to resources in the WPA, and will be reclaimed to approximate the natural contour, and stabilized.

- MM-3. Avoid locating waste dumps in WPAs. If no other alternative exists, ensure that safeguards are in place to prevent release of toxic or other hazardous materials.
- MM-4. For leasable minerals, prohibit surface occupancy within WPAs for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Where contracts already exist, modify the operating plan to be consistent with the riparian condition goals.
- MM-5. Prohibit common variety sand and gravel mining and extraction within WPAs (subject to valid permitted rights), unless consistent with riparian condition goals and needed for restoration purposes.

Fire/Fuels Management

- FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet desired riparian condition goals, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where management activities could be damaging to long-term ecosystem function.
- FM-2. Locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside of WPAs. If the only suitable location for such activities is within the WPA, an exemption may be granted following a review and recommendation by a resource advisor. The advisor will prescribe the location, use conditions, and rehabilitation requirements. Utilize an interdisciplinary team to predetermine suitable incident base and helibase locations.
- FM-3. Prohibit aerial application of chemical retardant, foam, or additives in WPAs. An exception may be warranted in situations where over-riding safety imperatives exist, or, following a review and recommendation by a resource advisor, when an escape would cause more long-term damage.
- FM-4. Design prescribed burn projects/prescriptions for areas adjacent to WPAs so that WPA areas are protected. Where riparian ecosystem management objectives would be enhanced through the use of fire, clearly identify the specific objectives and risks.
- FM-5. If WPAs are determined to be significantly adversely affected by a wildfire or a prescribed fire burning out of prescription, establish an emergency interdisciplinary rehabilitation team to determine the rehabilitation treatments needed to return riparian areas to desired conditions in the shortest time possible.
- FM-6. Use minimum impact suppression methods in WPAs. Consider potentially adverse fire suppression effects and the potentially adverse effects of wildfire damage during initial fire size-up,

initial suppression response, and in the development of the Escaped Fire Situation Analysis (EFSA).

Lands

- LH-1. For hydroelectric and other surface water development proposals, require instream flows and habitat conditions that maintain or restore riparian resources, channel conditions, and fish passage at or to levels that approximate favorable pre-project conditions. Coordinate this process with the appropriate state agencies. During relicensing of hydroelectric projects, make written and timely recommendations to FERC that require flows and habitat conditions that maintain/restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate state agencies.
- LH-2. Locate facilities that are not required within the WPA (such as control rooms, housing, temporary construction buildings, etc.) outside the WPA. Facilities within the WPA will be located, operated, and maintained to minimize effects on riparian resources, including, for example, maintenance of up-stream and down-stream passages, and screening intakes and diversions.
- LH-3. Review all Special Use Permits, rights-of-way, and easements affecting WPAs. When riparian condition goals are not being met, reduce impacts by methods including education or modification of existing Special Use Permits to achieve riparian condition goals. When granting easements or other rights-of-way across National Forest System lands to access private lands, apply the WPA standards and guidelines to provide the terms and conditions necessary to protect riparian resources on National Forest System lands.
- LH-4. Use land acquisition and exchange to consolidate inholdings, with the priority to protect and restore stocks at risk.

General Riparian Area Management

- RA-1. Exclude heavy equipment operation within WPAs, except for road construction and maintenance and in cases where an interdisciplinary team determines that such activity can be conducted without compromising riparian condition goals.
- RA-2. Fell hazard trees only when they are determined to pose an unacceptable safety risk. Such trees may be removed from WPAs only when adequate sources of woody debris remain to meet riparian condition goals. If long-term sources of woody debris are inadequate, and a tree is determined to pose an unacceptable safety risk, that risk must be reduced in a manner that contributes to woody debris objectives.

Watershed and Habitat Restoration

- WR-1. A watershed analysis is a prerequisite to planning, implementing, and monitoring all restoration projects. A preliminary watershed analysis may be sufficient to identify and prioritize watershed restoration measures and initiate restoration projects in

critical areas. A full watershed analysis is required, however, to develop an integrated basin-wide strategy for restoration and monitoring. Priority should be given to restoring watersheds supporting at-risk stocks.

- WR-2. Identify and control the causes of riparian area degradation prior to initiating restoration projects.
- WR-3. Where mixed ownership exists, encourage the development of Coordinated Resource Management Plans (CRMPs) or other cooperative agreements to meet riparian condition goals.
- WR-4. Employ restoration methods that promote the long-term genetic and ecological integrity of restored ecosystems.
- WR-5. Do not use mitigation or planned restoration as a substitute for preventing habitat degradation.

Table 6-K-1. Spawning and stream rearing habitat factors potentially limiting natural production for coastal Oregon anadromous salmonid species. Assessment of potential that a factor is limiting natural productions of a species is coded in the matrix as follows: H = high potential to limit natural production; M = medium potential; ? = insufficient information exists for making professional judgement; * = a priority for gathering new information that would help in restoration of fish populations (from Panel on Factors Potentially Limiting Natural Production, Oregon Governor's Coastal Salmonid Restoration Initiative, Oregon Department of Fish and Wildlife, Portland, OR).

FACTORS POTENTIALLY LIMITING NATURAL PRODUCTION COASTWIDE

	<u>SPAWNING HABITAT</u>				
	<u>Holding Pools</u>	<u>Migration Barriers</u>	<u>Gravel Quantity/Quality</u>	<u>Water Quantity/Quality</u>	<u>Temperature</u>
Coho	-	-	M	-	-
Chum	-	M	H	M	-
F. Chinook	M	-	H	?	-
S. Chinook	M	-	H	?	M
S. Steelhead	-	-	-	?	-
W. Steelhead	-	-	-	-	-
Cutthroat	?	M	?	-	-

STREAM REARING HABITAT

	<u>Channel Complexity</u>	<u>Streamflow</u>	<u>Temperature</u>	<u>Migration Barriers</u>	<u>Flood Plain and Wetland</u>	<u>Other</u>
Coho ¹	H	M	H	?*	H	
Chum ¹	-	-	-	?*	-	
F. Chinook	M*	M*	M*	?*	?*	
S. Chinook	H*	M*	M*	?*	?*	
S. Steelhead	H	H	H	?*	H	
W. Steelhead	H	H	H	?*	H	
Cutthroat	H	H*	H*	?*	H	

¹ Potential limitation of chum salmon production during the free-swimming freshwater phase of life cycle is believed to be minor because chum fry move quickly downstream to the estuary soon after emergence and do not reside in streams. Most downstream movement apparently occurs at night.

Table 6-K-2. Species of anadromous salmonids found on National Forests within the range of the northern spotted owl.

coho salmon	<u>Oncorhynchus kisutch</u>
chinook salmon	<u>O. tshawytscha</u>
sockeye salmon	<u>O. nerka</u>
chum salmon	<u>O. keta</u>
pink salmon	<u>O. gorbuscha</u>
steelhead trout	<u>O. mykiss</u>
cutthroat trout	<u>O. clarkii clarkii</u>

Table 6-K-3. Changes in the frequency of deep pools (>6 feet) in streams within the northern spotted owl forests from 1935 to 1992.

		1935-1945		1987-1992		Percent
	miles	#	#/mi	#	#/mi	Change
Western Washington						
Cascades						
Cowlitz River Basin	47.0	337	7.2	137	29	-60%
Lewis River Basin	4.8	22	4.6	13	2.7	-41%
Wind River Basin	35.4	75	2.1	80	2.3	10%
Coastal						
Grays River Basin	20.7	107	5.2	34	1.6	-69%
Elochoman River Basin	21.5	79	3.7	13	0.6	-84%
Abernathy Basin	8.3	3	0.4	3	0.4	-NC
Germany Basin	8.0	7	0.9	4	0.5	-44%
Coweeman River Basin	26.4	87	3.3	4	0.2	-94%
Eastern Washington						
Yakima River Basin	28.5	98	3.4	14	0.5	-85%
Wenatchee River Basin	60.7	143	2.4	125	2.1	-13%
Methow River Basin	119.0	106	0.9	52	0.4	-56%
Coastal Oregon						
Lewis and Clark River	10.4	47	4.5	10	1.0	-78%
Clatskanie River	15.5	135	8.7	20	1.3	-85%

Table 6-K-4. Changes in the frequency of large pools 25 yd² and >3 feet deep) in the western cascades province of the northern spotted owl forests from 1935 to 1992.

		1935-1945		1987-1992		Percent
	miles	#	#/mi	#	#/mi	Change
Western Cascades						
Washington						
Cowlitz River Basin	47.0	751	16.0	472	10.0	-38%
Wind River Basin	35.4	162	4.6	431	12.2	165%
Lewis River Basin	4.8	51	10.6	70	14.6	38%
Oregon						
Willamette River Basin	144.4	1998	13.8	1049	7.3	-47%

Figure 6-K-1. Range and status of anadromous salmonid stocks at risk in Northern California, Oregon, Washington, and Idaho. This map was produced from a 1:500,000 scale stream network developed by EPA. Due to the small scale of the map, streams smaller than 5th order are not displayed. The result is that some small coastal and headwater tributaries are not depicted. The map represents available data for all land ownerships, both public and private, individual drainages may have more than one stock at risk, with different risk codes. In this case, the highest risk code was assigned to the entire drainage.

The risk codes are those of Nehlsen et al. (1991) and are defined as follows:

Presently Listed: all stocks currently listed under the Endangered Species Act.

High Risk of Extinction: not self-sustaining (spawner:spawner ratio <1); continue to decline despite and conservation efforts.

Moderate Risk of Extinction: presently self-sustaining (spawner:spawner ratio = 1 or slightly more) after previously declining more than natural variation would account for.

Special Concern: 1) relatively minor disturbances could make population not self-sustaining, 2) insufficient information on population trend, but available data suggests depletion, 3) relatively large ongoing release of non-native fish and the potential for inbreeding with the native population exists, 4) population is not presently depleted, but requires attention because of a unique character.

Data for this map was derived from Nehlsen et al. 1991, Johnson et al. 1991, and Higgins et al. 1992.

Anadromous Stocks

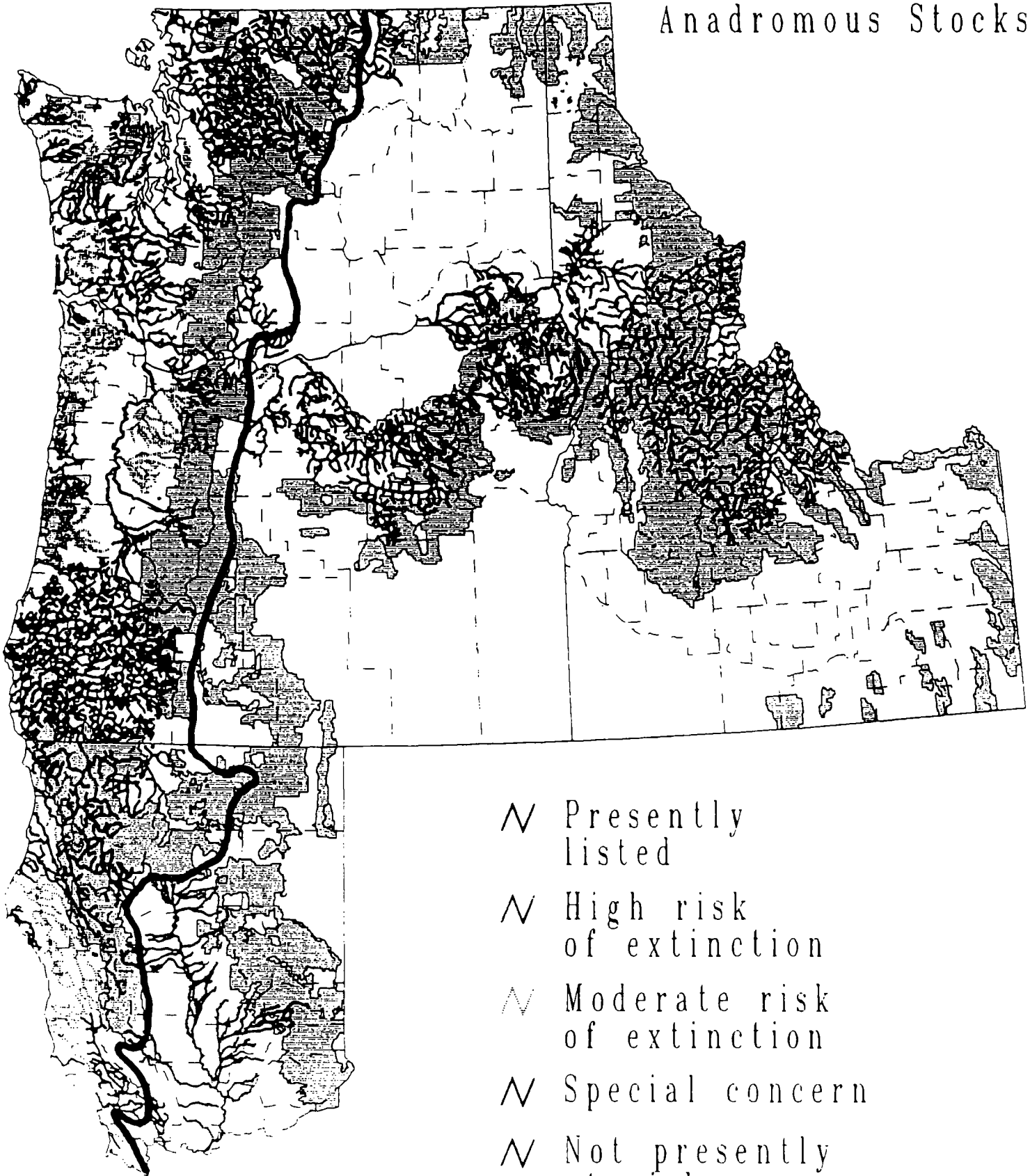
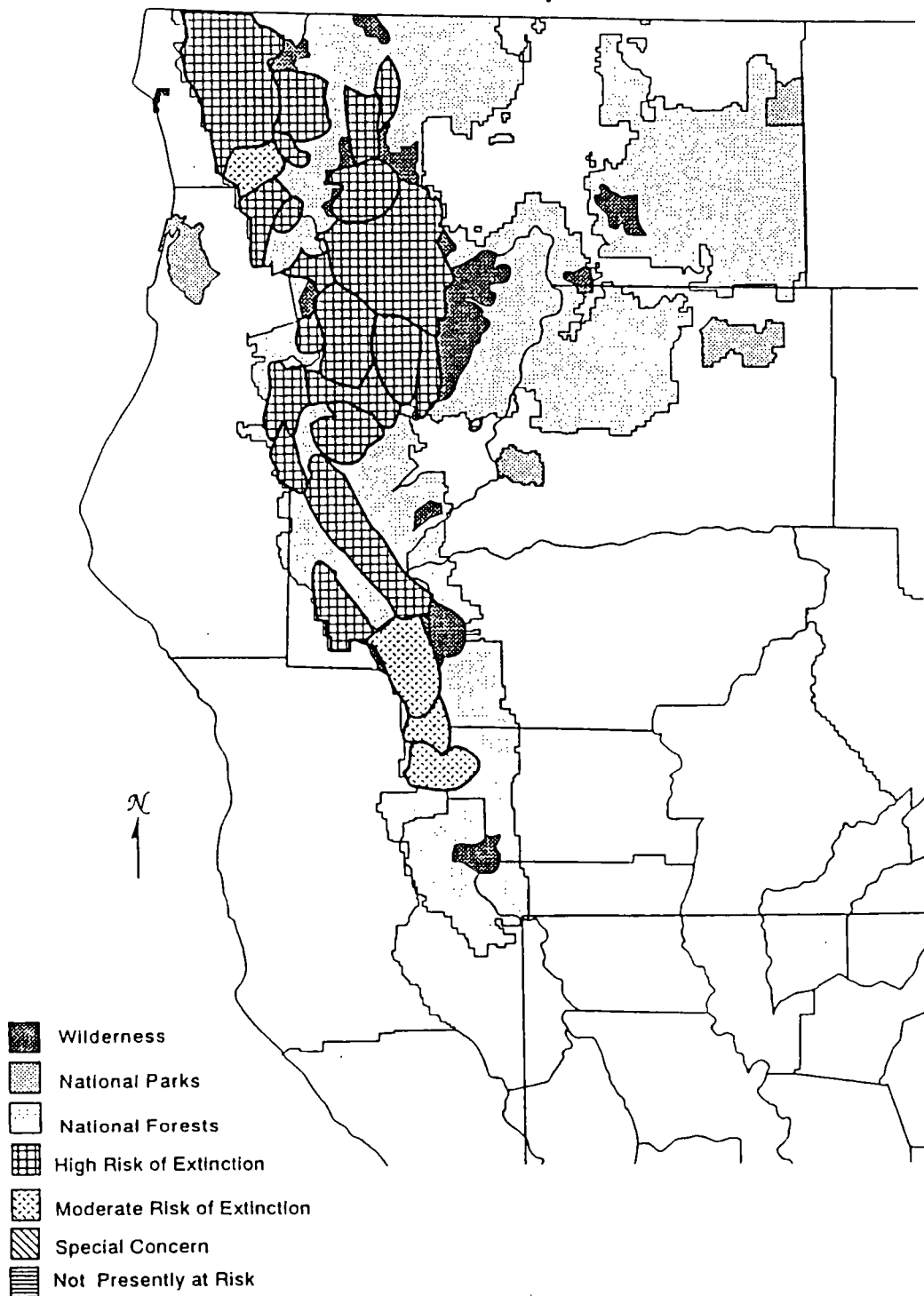


Figure 6-K-2. Schematic diagram of a Watershed Protection Area (WPA). Included within the WPA are all perennial and intermittent streams, wetlands, landslides, and landslide-prone areas.

CALIFORNIA

Status of Anadromous Salmonid Stocks In Key Watersheds



S. Arbogast—1/11/93

Figure 6-K-3. Location of key watersheds which could serve as aquatic biodiversity management areas in California and status of anadromous salmonid stocks (as determined by Nehlsen et al. 1991 and Higgins et al. 1992) within streams.

OREGON

Status of Anadromous Salmonid Stocks in Key Watersheds

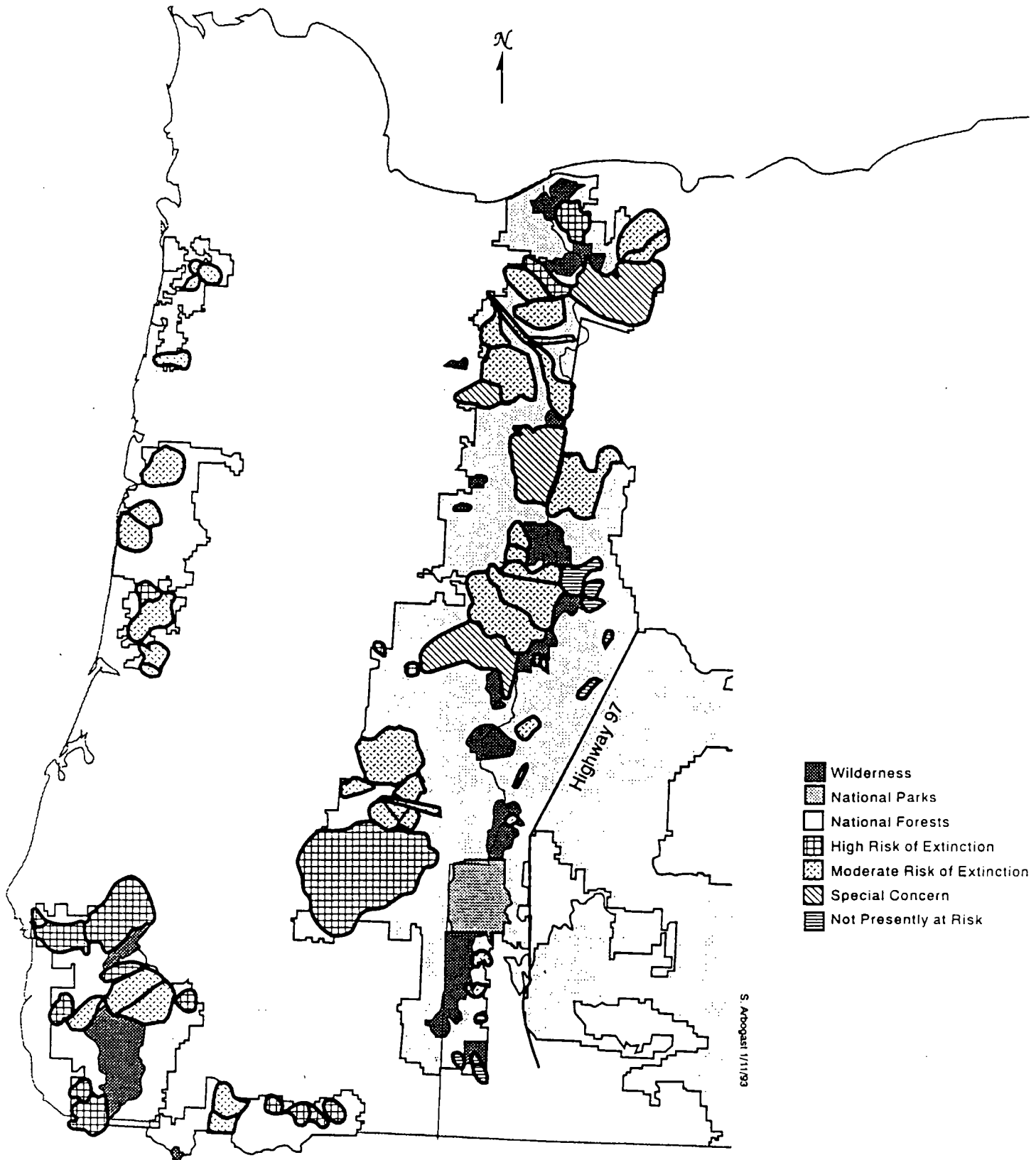


Figure 6-K-4. Location of key watersheds which could serve as aquatic biodiversity management areas in Oregon and status of anadromous salmonid stocks (as determined by Nehlsen et al. 1991) and other forests (Williams et al 1989).

WASHINGTON

Status of Anadromous Salmonid Stocks in Key Watersheds

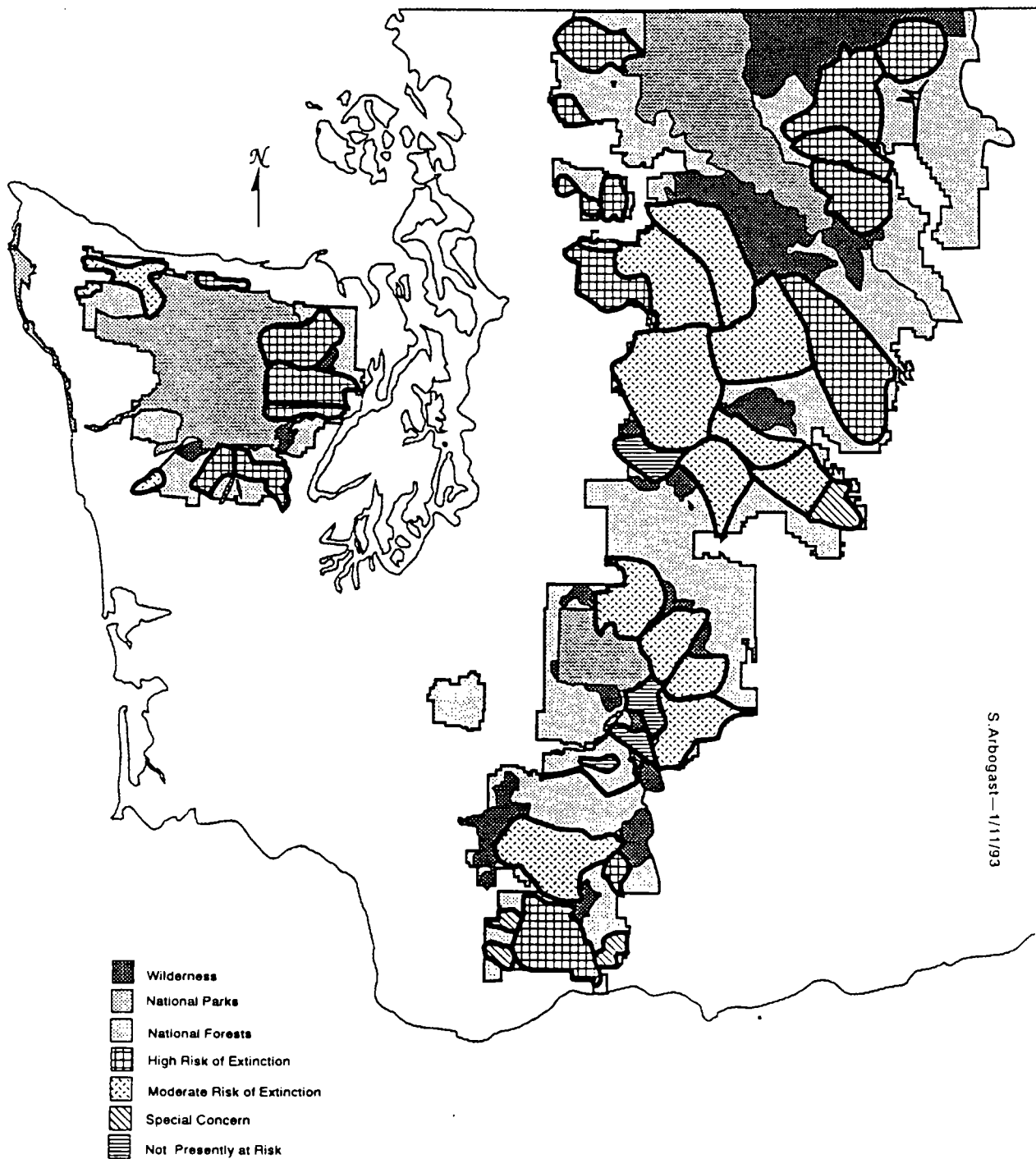


Figure 6-K-5. Location of key watersheds which could serve as aquatic biodiversity management areas in Washington and status of anadromous salmonid stocks (as determined by Nehlsen et al. 1991) and other fishes (Williams et al. 1989).

VI. LITERATURE CITED

- Allendorf, F.W. 1988. Conservation biology of fishes. Conservation biology. 2:145-148.
- Allendorf, F.W. 1988. Conservation biology of fishes. Conservation Biology. 4:275-284.
- Angermeier, P.L.; Karr, J.R. 1984. Relationship between woody debris and fish habitat in a small warmwater stream. Transactions of the American Fisheries Society. 133:716-726.
- Baltz, D.M.; Moyle, P.B.; Knight, N.J. 1982. Competitive interactions between benthic stream fishes, riffle sculpin (Cottus gulosus), and speckled dace (Rhinichthys osculus). Canadian Journal of Fisheries and Aquatic Sciences. 39:1,502-1,511.
- Benda, L.; Zhang, W. 1990. The hydrological and geomorphological characteristics of landslide/dam-break floods in the Cascade Range of Washington. EOS, Transactions of the American Geophysical Union.
- Benda, L.; Beechie, T.J.; Wissmar, R.C.; Johnson, A. 1992. Morphology and evolution of salmonid habitats in a recently deglaciated river basin, Washington State, USA. Canadian Journal of Fisheries and Aquatic Sciences. 49:1246-1256.
- Benner, P.A. 1992. Historical reconstruction of the Coquille River and surrounding landscape. Sections 3.2, 3.3 in: The action plan for Oregon coastal watersheds, estuaries, and ocean waters. Near Coastal Waters National Pilot Project, EPA, 1988-1991. Portland, OR: Conducted by the DEQ.
- Berkman, H.E.; Rabini, C.F. 1987. Effect of siltation on stream fish communities. Environmental Biology of Fishes. 18:285-294.
- Beschta, R.L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research. 14:1011-1016.
- Beschta, R.L.; Bilby, R.E.; Brown, G.W.; Holtby, L.B.; Hofstra, T.D. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in: Salo, E.O.; Cundy, T.W., eds. Forestry and fisheries interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.
- Bilby, R.E.; Ward, J.W. 1991. Large woody debris characteristics in streams draining old-growth, clear-cut, and second-growth forest in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences. 48:2,499-2,508.
- Bisson, P.A.; Bilby, R.E.; Bryant, M.D.; Dolloff, C.A.; Grette, G.B.; House, R.A.; Murphy, M.L.; Koski, K.V.; Sedell, J.R. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. Pages 143-190 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Bisson, P.A.; Quinn, T.P.; Reeves, G.H.; Gregory, S.V. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. Pages 189-232 in: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag.

Bisson, P.A.; Sedell, J.R. 1984. Salmonid populations in streams in clearcut vs. old-growth forest of western Washington. Pages 121-129 in: Meehan, W.R.; Merrell, Jr., T.R.; Hanley, T.A., eds. Fish and wildlife relationships in old-growth forest: Proceedings of the symposium. Asheville, NC: American Institute of Fishery Research Biologists.

Bjornn, T.C.; Reiser, D.W. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication. 19:83-138.

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to its fishery resources. No. 2, Area I, Washington streams from the mouth of the Columbia River to and including the Klickitat River. Special Scientific Report No. 62. U.S. Fish and Wildlife Service. 110 p.

Bryant, F.G.; Parkhurst, Z.E. 1950. Survey of the Columbia River and its tributaries. No. 4, Area III, Washington streams from the Klickitat and Snake Rivers to Grande Coulee Dam, with notes on the Columbia and its tributaries above Grande Coulee Dam. Special Scientific Reports on Fisheries No. 37. U.S. Fish and Wildlife Service. 108 p.

Bryant, M.D. 1980. Evolution of large, organic debris after timber harvest: Maybeso Creek, 1949 to 1978. General Technical Report PNW-101. USDA Forest Service.

Bury, R.B.; Corn, P.S.; Aubry, K.B.; Gilbert, F.F.; Jones, L.L.C. 1991. Aquatic amphibian communities in Oregon and Washington. Ruggiero, L.F.; Aubry, K.B.; Carey, A.B.; Huff, M.H., technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

Cederholm, C.J.; Reid, L.M. 1987. Impact of forest management on coho salmon (Oncorhynchus kisutch) populations of the Clearwater River, Washington: a project summary. Pages 373-398 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society. 117:1-21.

Chen, J.; Franklin, J.F.; Spies, T.A. [In press]. Microclimatic gradients from the clearcut edge into the old-growth Douglas-fir forest. Landscape Ecology.

Crowder, L.B.; Cooper, W.E. 1982. Habitat structural complexity and the interaction between bluegill and their prey. Ecology. 63:1802-1813.

Everest, F.H.; Beschta, R.L.; Scrivener, J.C.; Koski, K.V.; Sedell, J.R.; Cederholm, C.J. 1987. Fine sediment and salmonid production: a paradox. Pages 98-142 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Frissel, C.A. 1992. Cumulative impacts of land use on salmon habitat in south coastal Oregon. Corvallis, OR: Oregon State University. 227 p. Ph.D. dissertation.

Furniss, M.J.; Roelofs, T.D.; Yee, C.S. 1991. Road construction and maintenance. American Fisheries Society Special Publication. 19:297-324.

Gall, G.A.E. 1987. Inbreeding. Pages 47-87 in: Ryman, N.; Utter, F., eds. Population genetics and fishery management. Seattle, WA: Washington Sea Grant, University of Washington Press.

Glancy, P.A. 1973. A reconnaissance of streamflow and fluvial sediment transport, Incline Village Area, Lake Tahoe, Nevada. Nevada Division of Water Resources, Water Information Series, Second Progress Report. Carson City, NV.

Gonor, J.J.; Sedell, J.R.; Benner, P.A. 1988. What we know about large trees in estuaries, in the sea, and on coastal beaches. Pages 83-111 in: Maser, C., Tarrant, R.F.; Trappe, J.M.; Franklin, J.F., technical eds. From the forest to the sea: a story of fallen trees. General Technical Report PNW-GTR-229. USDA Forest Service, Pacific Northwest Research Station.

Gorman, O.T.; Karr, J.W. 1978. Habitat structure and stream fish communities. Ecology. 59:507-515.

Grant, G.E. 1986. Downstream effects of timber harvest activities on the channel and valley floor morphology of western Cascade streams. Baltimore, MD: Johns Hopkins University. Ph.D. dissertation.

Grant, G.E.; Wolff, A.L. 1991. Long-term patterns of sediment transport after timber harvest, western Cascade Mountains, Oregon, USA. Pages 31-40 in: Sediment and stream water quality in a changing environment: trends and explanation: Proceedings of the symposium; 1991 August; Vienna. IAHS Publication 203.

Gregory, S.; Ashkenas, L. 1990. Riparian management guide, Willamette National Forest. Portland, OR: USDA Forest Service, Pacific Northwest Region. 120 p.

Gregory, S.V.; Swanson, F.J.; McKee, W.A.; Cummins, K.W. 1991. An ecosystem perspective of riparian zones. BioScience. 41:540-551.

Groot, C.; Margolis, L., eds. 1991. Pacific salmon life histories. Vancouver, BC: UBC Press. 564 p.

Gurtz, M.E.; Wallace, J.B. 1984. Substrate-mediated response of invertebrates to disturbance. Ecology. 65:1,556-1,569.

Hall, J.D.; Brown, G.W.; Lantz, R.L. 1987. The Alsea watershed study: a retrospective. Pages 399-416 in: Salo, E.O.; Cundy, T.W., eds. Streamside

management: forestry and fishery interactions. Institute of Forest Resources Contribution No. 57. Seattle, WA: University of Washington.

Hartman, G.H.; Scrivener, J.C. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences. 223:1-148.

Hicks, B.J. 1990. The influence of geology and timber harvest on channel geomorphology and salmonid populations in Oregon Coast Range streams. Corvallis, OR: Oregon State University. 199 p. Ph.D. dissertation.

Hicks, B.J.; Beschta, R.L.; Harr, R.D. 1991. Long-term changes in streamflow following logging in western Oregon and associated fisheries implications. Water Resources Bulletin. 27:217-226.

Hicks, B.J.; Hall, J.D.; Bisson, P.A.; Sedell, J.R. 1991. Responses of salmonids to habitat change. American Fisheries Society Special Publication. 19:483-518.

Higgins, P.; Dobush, S.; Fuller, D. 1992. Factors in northern California threatening stocks with extinction. Humboldt Chapter, American Fisheries Society. 25 p. Unpublished report.

Holtby, L.B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences. 45:502-515.

Holtby, L.B.; Scrivener, J.C. 1989. Observed and simulated effects of climatic variability, clear-cut logging and fishing on the numbers of chum salmon (Oncorhynchus keta) and coho salmon (O. kisutch) returning to Carnation Creek, British Columbia. Canadian Special Publication of Fisheries and Aquatic Sciences. 105:62-81.

House, R.A.; Boehne, P.L. 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. Western Journal of Applied Forestry. 2:84-87.

Janda, R.J.; Nolan, K.M.; Harden, D.R.; Colman, S.M. 1975. Watershed conditions in the drainage basin of Redwood Creek, Humboldt County, California as of 1973. U.S. Geological Survey Open-File Report 75-568. 266 p.

Johnson, K.N.; Franklin, J.F.; Thomas, J.W.; Gordon, J. 1991. Alternatives for management of late-successional forests of the Pacific Northwest. A report to the Agriculture Committee and the Merchant Marine Committee of the U. S. House of Representatives. 59 p.

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications. 1:66-84.

Karr, J.R.; Fausch, K.D.; Angermeier, P.L.; Yaut, P.R.; Schlosser, I.J. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey, Special Publication 5. Champaign, IL.

Kaufmann, P.R. 1987. Channel morphology and hydraulic characteristics of torrent-impacted streams in the Oregon Coast Range, U.S.A. Corvallis, OR: Oregon State University. 235 p. Ph.D. dissertation.

Kelly, J.R.; Harwell, M.A. 1990. Indicators of ecosystem recovery. *Environmental Management*. 14:527-546.

Kelsey, H.M.; Madej, M.A.; Pitlick, J.; Coughlan, M.; Best, D.; Bending, R.; Stroud, P. 1981. Sediment sources and sediment transport in the Redwood Creek Basin: a progress report. Redwood National Park Research and Development Technical Report 3. National Park Service. 114 p.

Ketcheson, G.L.; Froehlich, H.A. 1978. Hydrology factors and environmental impacts of mass soil movements in the Oregon Coast Range. Report by the Water Resources Research Institute. Corvallis, OR: Oregon State University.

Leidy, R.A. 1984. Distribution and ecology of stream fishes in the San Francisco Bay Drainage. *Hilgardia*. 52:152.

Li, H.W.; Schreck, C.B.; Bond, C.E.; Rexstad, E. 1987. Factors influencing changes in fish assemblages of Pacific Northwest streams. Pages 193-202 in: Matthews, W.J.; Heins, D.C., eds. *Community and evolutionary ecology of North American stream fishes*. Norman, OK: University of Oklahoma Press.

Lienkaemper, G.W.; Swanson, F.J. 1987. Dynamics of coarse woody debris in streams in old-growth Douglas-fir forests. *Canadian Journal of Forest Research*. 17:150-156.

Madej, M.A. 1984. Recent changes in channel-stored sediment Redwood Creek, California. Redwood National Park Research and Development Technical Report 11. National Park Service. 54 p.

Marion, D.A. 1981. Landslide occurrence in the Blue River drainage, Oregon. Corvallis, OR: Oregon State University. M.S. thesis.

Maser, C.; Tarrant, R.F.; Trappe, J.M.; Franklin, J.F. 1988. From the forest to the sea: a story of fallen trees. General Technical Report PNW-GTR-229. USDA Forest Service. Portland, OR.

McDade, M.H. 1988. The source area for coarse woody debris in small streams in western Oregon and Washington. Corvallis, OR: Oregon State University. 69 p. M.S. thesis.

McDade, M.H.; Swanson, F.J.; McKee, W.A.; Franklin, J.F.; Van Sickle, J. 1990. Source distances for coarse woody debris entering small streams in western Oregon and Washington. *Canadian Journal of Forest Research*. 20:326-330.

McSwain, M.D. 1987. Summer stream temperatures and channel characteristics of a southwestern Oregon coastal stream. Corvallis, OR: Oregon State University. 99 p. M.S. thesis.

Meehan, W.R., ed. 1991. Influences of forest and rangeland management on salmonid fishes and their habitat. American Fisheries Society Special Publication 19.

Meehan, W.R.; Bjornn, T.C. 1991. Salmonid distributions and life histories. American Fisheries Society Special Publication. 19:47-82.

Megahan, W.F. 1982. Pages 114-121 in: Swanson, [and others]. Channel sediment storage behind obstructions in forest drainage basins draining the granitic bedrock of the Idaho batholith.

Megahan, W.F.; Kidd, Jr., W.J. 1972. Effects of logging and logging roads on erosion and sediment deposition from steep terrain. Journal of Forestry. 70:136-141.

Megahan, W.F.; Potyondy, J.P.; Syedbagheri, K.A. 1992. Best management practices and cumulative effects from sedimentation in the South Fork Salmon River: an Idaho case study. Pages 401-414 in: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New, York, NY: Springer-Verlag.

Morrison, P.H. 1975. Ecological and geomorphological consequences of mass movements in the Alder Creek watershed and implications for forest land management. Eugene, OR: University of Oregon. B.S. thesis.

Moyle, P.B.; Sato, G.M. 1991. On the design of preserves to protect native fishes. Pages 155-169 in: Minckley, W.L.; Deacon, J.E., eds. Battle against extinction: native fish management in the American west. Tucson, AZ: University of Arizona Press. 518 p.

Moyle, P.B.; Williams, J.E. 1990. Biodiversity loss in the temperate zone: decline of the native fish fauna of California. Conservation Biology. 4:275-284.

Naiman, R.J.; Beechie, T.J.; Benda, L.E.; Berg, D.R.; Bisson, P.A.; MacDonald, L.H.; O'Connor, M.D.; Olson, P.L.; Steel, E.A. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. Pages 127-188 in: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag.

Narver, D.W. 1971. Effects of logging debris on fish production. Pages 100-111 in: Krygier, J.T.; Hall, J.D., directors. Forest land uses and stream environment; Proceedings of the symposium. Corvallis, OR: Oregon State University, Continuing Education Publications.

Nehlsen, W.; Williams, J.E.; Lichatowich, J.A. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2):4-21.

Niemi, G.J., [and others]. 1990. Overview of case studies on recovery of aquatic systems from disturbance. Environmental Management. 14:5701-587.

O'Loughlin, C.L. 1972. An investigation of the stability of the steep-land forest soils in the Coast Mountains, southwest British Columbia. Vancouver, BC: University of British Columbia. Ph.D. dissertation.

Pacific Fishery Management Council. 1992. Freshwater habitat, salmon produced, escapements for natural spawning along the Pacific coast of the United States. Report of the Anadromous Salmonid Task Force. Portland, OR.

Parkhurst, Z.E. 1950a. Survey of the Columbia River and its tributaries, Part 6, Area V, Snake River from the mouth through the Grande Ronde River. Special Scientific Report. U.S. Fish and Wildlife Service. Fisheries. 39:58.

Parkhurst, Z.E. 1950b. Survey of the Columbia River and its tributaries, Part 7, Area VI, Snake River from above the Grande Ronde River through the Payette River. Special Scientific Report. U.S. Fish and Wildlife Service. Fisheries. 40:95.

Parkhurst, Z.E. 1950c. Survey of the Columbia River and its tributaries, Part 8, Area VIII, Snake River above Payette River to upper Salmon Falls. Special Scientific Report. U.S. Fish and Wildlife Service. Fisheries. 57:19.

Parkhurst, Z.E.; Bryant, F.G.; Nelson, R.S. 1950. Survey of the Columbia River and its tributaries, Part 3. Special Scientific Report. U.S. Fish and Wildlife Service. Fisheries. 36:103.

Quinn, T.P.; Tallman, R.F. 1987. Seasonal environmental predictability in riverine fishes. Environmental Biology of Fishes. 18:155-159.

Raynor, G.S. 1971. Wind and temperature structure in a coniferous forest and a contiguous field. Forest Science. 17:351-363.

Reeves, G.H.; Everest, F.H.; Hall, J.D. 1987. Interactions between the redbside shiner (Richardsonius balteatus) and the steelhead trout (Salmo gairdneri) in western Oregon: the influence of water temperature. Canadian Journal of Fisheries and Aquatic Sciences. 44:1603-1613.

Reeves, G.H.; Everest, F.H.; Sedell, J.R. [In press]. Diversity of juvenile anadromous salmonid assemblages in basins in coastal Oregon, U.S.A. with different levels of timber harvest. Transactions of the American Fisheries Society.

Reeves, G.H.; Hall, J.D.; Roelofs, T.D.; Hickman, T.L.; Baker, C.O. 1991. Rehabilitating and modifying stream habitats. American Fisheries Society Special Publication. 19:519-557.

Reeves, G.H.; Sedell, J.R. 1992. An ecosystem approach to the conservation and management of freshwater habitat for anadromous salmonids in the Pacific Northwest. Transactions of the 57th North American Wildlife and Natural Resources Conference. 408-415 p.

Reid, L.M.; Dunne, T. 1984. Sediment production from forest road surfaces. Water Resources Research. 20:1753-1761.

Resh, V.H., Brown, A.V.; Covich, A.P.; Gurtz, M.E.; Li, H.W.; Minshall, G.W.; Reice, S.R.; Sheldon, A.L.; Wallace, J.B.; Wissmar, R.C. 1988. The role of disturbance in stream ecology. Journal of North American Benthological Society. 7:433-455.

Rich, W.H. 1948. A survey of the Columbia River and its tributaries with special reference to the management of its fishery resources. Special Scientific Report No. 51. U.S. Fish and Wildlife Service. 25 p.

Ricker, W. E. 1972. Hereditary and environmental factors affecting certain salmonid populations. Pages 19-160 in: Simon, R.C.; Larkin, P.A., eds. The stock concept in Pacific salmon. Vancouver, BC: University of British Columbia.

Rutherford, D.A.; Echelle, A.A.; Maughan, O.E. 1987. Changes in the fauna of the Little River drainage, southeastern Oklahoma, 1948-1955 to 1981-1982: a test of the hypothesis of environmental degradation. Pages 178-183 in: Matthews, W.J.; Heins, D.C., eds. Community and evolutionary ecology of North American stream fishes. Norman, OK: University of Oklahoma Press.

Salo, E.O.; Cundy, T.W., eds. 1987. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Schlosser, I.J. 1982. Trophic structure, reproductive success, and growth rate of fish in a natural and modified headwater stream. Canadian Journal of Fisheries and Aquatic Sciences. 39:968-978.

Schlosser, I.J. 1988. Predation risk and habitat selection by two size classes of a stream cyprinid: experimental test of a hypothesis. Oikos. 52:36-40.

Schwartz, J.S. 1991. Influence of geomorphology and land use on distribution and abundance of salmonids in a coastal Oregon basin. Corvallis, OR: Oregon State University. 297 p. M.S thesis.

Scott, J.B.; Steward, C.R.; Stober, Q.J. 1986. Effects of urban development on fish population dynamics in Kelsey Creek, Washington. Transactions of the American Fisheries Society. 115:555-567.

Scrivener, J.C.; Brownlee, M.J. 1989. Effects of forest harvesting on spawning gravel and incubation survival of chum (Oncorhynchus keta) and coho salmon (O. kisutch) in Carnation Creek, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences. 46:681-696.

Sedell, J.R.; Beschta. 1991. Bringing back the "bio" in bioengineering. In: Colt, J.; Dendall, S., eds. Fisheries bioengineering: Proceedings of the symposium; Bethesda, MD. American Fisheries Society. 10:160-175.

Sedell, J.R.; Everest, F.H. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing. Draft report, December 1990. Corvallis, OR: USDA Forest Service, Pacific Northwest Research Station. 7 p.

Sedell, J.R.; Froggatt, J.L. 1984. Importance of streamside forests to large rivers: the isolation of the Willamette River, Oregon, USA, from its floodplain by snagging and streamside forest removal. Verh. Internat. Verein. Limnol. 22:1,828-1,834.

Sedell, J.R.; Leone, F.N.; Duval, W.S. 1991. American Fisheries Society Special Publication. 19:325-368.

Sedell, J.R.; Luchessa, K.J. 1982. Using the historical record as an aid to salmonid habitat enhancement. Pages 210-223 in: Armantrout, N.B., ed. Acquisition and utilization of aquatic inventory information: Proceedings of the symposium; Bethesda, MD. American Fisheries Society, Western Division.

Sedell, J.R.; Reeves, G.H.; Hauer, F.R.; Stanford, J.A.; Hawkins, C.P. 1990. Role of refugia in recovery from disturbance: modern fragmented and disconnected river systems. Environmental Management. 14:711-724.

Sheldon, A.I. 1988. Conservation of stream fishes: patterns of diversity, rarity, and risk. Conservation Biology. 2:149-156.

Stanford, J.A.; Ward, J.V. 1988. The hyporheic habitat of river ecosystems. Nature. 335:64-66.

Statzner, B.; Gore, J.A.; Resh, V.H. 1988. Hydraulic stream ecology: observed patterns and potential applications. Journal of the North American Benthological Society. 7:307-360.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions of the American Geophysical Union. 38:913-920.

Sullivan, K.T.; Lisle, E.; Dollof, C.A.; Grant, G.E.; Reid, L.M. 1987. Stream channels: the link between forests and fish. Pages 39-97 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Swanson, F.J.; Dyrness, C.T. 1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology. 3:393-396.

Swanson, F.J.; Gregory, S.V.; Sedell, J.R.; Campbell, A.G. 1982a. Land-water interactions: the riparian zone. Pages 267-291 in: Edmonds, R.L., ed. Analysis of coniferous forest ecosystems in the western United States. Stroudsburg, PA: Hutchinson Ross.

Swanson, F.J.; Swanson, M.M.; Woods, C. 1977. Inventory of mass erosion in the Mapleton Ranger District, Siuslaw National Forest. Final Report. Corvallis, OR: USDA Forest Service, Forestry Sciences Laboratory.

Swanston, D.N. 1991. Natural processes. American Fisheries Society Special Publication. 19:139-179.

Swanston, D.N.; Swanson, F.J. 1976. Timber harvesting, mass erosion, and steep-land forest geomorphology in the Pacific Northwest. In: Coates, D.R., ed. Geomorphology and engineering. Stroudsburg, PA: Dowden, Hutchinson, and Ross, Inc. 199-221 p.

Sweeney, B.W.; Vannote, R.L. 1978. Size variation and the distribution of hemimetabolous aquatic insects: two thermal equilibrium hypotheses. Science.

Van Sickle, J., Gregory, S.V. 1990. Modelling inputs of large woody debris to streams from falling trees. Canadian Journal of Forest Research. 20:1593-1601.

Vannote, R.L.; Minshall, G.W.; Cummins, K.W.; Sedell, J.R.; Cushing, C.E. 1980. The river continuum concept. *Canadian Journal of Fisheries and Aquatic Sciences*. 40:452-461

Washington Forest Practice Board. 1992. Standard methodology for conducting watershed analysis under chapter 222-22 WAC (Version 1.10). Olympia, WA: Washington Forest Practice Board.

Williams, J.E. 1991. Preserves and refuges for native western fishes: history and management. Pages 171-189 in: Minckley, W.L; Deacon, J.E., eds. *Battle against extinction: native fish management in the American west*. Tucson, AZ: University of Arizona Press. 518 p.

Williams, J.E.; Johnson, J.E.; Hendrickson, D.A.; Conreras-Balderas, S.; Williams, J.D.; Navarro-Mendoza, M.; McAllister, D.E.; Bacon, J.E. 1989. Fishes of North America endangered, threatened, and of special concern. *Fisheries*. 14(6):2-20.

Yount, J.D.; Niemi, G.J. 1990. Recovery of lotic communities from disturbance--a narrative review of case studies. *Environmental Management*. 14:547-569.

Ziemer, R.R.; Lewis, J.; Rice, R.M.; Lisle, T.E. 1991a. The cumulative watershed effects of forest management strategies. *Journal of Environmental Quality*. 20(1):36-42.

Ziemer, R.R.; Lewis, J.; Lisle, T.E.; Rice, R.M. 1991b. Long-term sedimentation effects of different patterns of timber harvesting. Sediment and stream water quality in a changing environment: trends and explanation: XX General Assembly, International Union of Geodesy and Geophysics; Proceedings of the symposium; 1991 August 11-24; Vienna, Austria. IAHS Publication no. 203. Wallingford, UK. 143-150 p.

Ziemer, R.R.; Swanston, D.N. 1977. Root strength changes after logging in southeast Alaska. Research Note PNW-306. USDA Forest Service.

CHAPTER 7

REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION

CHAPTER 7

REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION

Table of Contents

Ongoing Activities.....	
Proposed or Planned Activities.....	
Adaptive Management.....	
Ongoing Planning and Evaluations.....	
Research and Monitoring.....	
Interagency Coordination.....	

CHAPTER 7
REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION

Our analyses focused on three aspects of the FEIS (Chapter 1) that were considered deficient by the United States District Court. In addressing these deficiencies, the Scientific Analysis Team (SAT) developed, both in response to the Court and instructions from the Chief of the Forest Service, recommendations for needed mitigations. Mitigation refers to (1) measures or actions taken that would soften or lessen adverse effects of management activities--such as the recommended additions to the Habitat Conservation Area (HCA) network in the FEIS preferred alternative to compensate of increased risk associated with Bureau of Land Management (BLM) management of spotted owl habitat and (2) in some cases avoidance of adverse effects resulting from adoption of standards and guidelines recommended to provide mitigation for other species associated with late-successional or old-growth forests that were judged to be at risk under current land management plans plus the preferred alternative in the FEIS.

The SAT's suggested overall mitigation strategy follows a step-down approach (also called tiering), as described in Chapter 6. We developed and recommended mitigations (standards and guidelines) at each step or tier in that process. It must be understood that, although recommendations for each phase or step were developed individually, all recommendations should be viewed collectively and as a complete package. If some parts are not applied, and alternate mitigations of equal effect applied, all the species benefited by that mitigation will be compromised as well as all other species in the subsequent steps.

Our proposed strategy can be summarized as follows:

<u>Step</u>	<u>Mitigation</u>	<u>Number of Plant and Vertebrate Species Protected By This Step</u>	<u>Cumulative Number of Plant and Vertebrate Species Protected</u>
1.	Existing Forest Land and Resource Management Plans--See Individual Forest Plans °Land allocation that protect old-growth associated species including wilderness areas °Standards and guidelines that protect old-growth associated species	164	164
2.	Interagency Scientific Committee (ISC) Strategy for Conservation of Northern Spotted Owls applied to National Forests--see Thomas et al. (1990) °Standards and guidelines from Step 1 °Additions of HCAs °Addition of 50-11-40 rule	119	429

Standards and guidelines for
conducting activities in HCAs

- | | | | |
|----|--|-----|-----|
| 3. | ISC or an alternative that provides for a high probability of viable owl populations plus additions to components for BLM Risk--see Chapter 5, page ***
°Standards and Guidelines from Steps 1 and 2
°Addition of 410,000 acres to the HCA network on National Forests if BLM adopts PAs of draft Resource Management Plans
°If BLM follows the ISC Strategy or adopts an alternative equal to or superior ISC Strategy--no mitigation required | 1 | 284 |
| 4. | Watershed Protection Areas--see Chapter 6, page ***
°Standards and guidelines from Steps 1, 2, and 3
°Establishes buffer for aquatic ecosystems (watershed protection areas)
°Standards and guidelines for conducting activities in watershed protection areas to protect habitat | 133 | 417 |
| 5. | Marbled Murrelet Standards--see Chapter 6, page ***
°Standards and Guidelines from Steps 1-4
°Protection of all suitable habitat within 35-50 miles from marine environments
°Protects younger forest stands to serve as recruitment habitat
°Prescribes buffers for sites occupied by marbled murrelets | 24 | 441 |
| 6. | Protection of Rare and Locally Endemic Species--see Chapter 6, page ***
°Standards and Guidelines from Steps 1-5
°Identify and designate protection of specific localities
°Addition of standards and guidelines to reduce habitat loss or conflicts. | 17 | 458 |

7. Additional Mitigation for Species 5 463
in Upland Forest Matrix--see
Chapter 6, page ***
°Standards and Guidelines from
Steps 1-6
°Additional standards and
guidelines to maintain
critical components of habitat
for particular species not
provided for by other steps

Provided that all the recommended mitigation steps and associated standards and guidelines are fully implemented within the time needed to fulfill legal requirements our mitigation applicable to such changes, the SAT believes that package will provide a high likelihood of the existence of well-distributed populations of some 463 species associated with late-successional old-growth forests on the National Forests located within the range of the northern spotted owl.

For the remaining old-growth associated species (52 species of plants and vertebrates including 22 nonvascular plants and fungi, 18 vascular plants, 12 mammals and 149 species of invertebrates), major uncertainties due to lack of scientific information about the distribution and habitat requirements of these species (See Chapter 6, Appendix J), preclude our stating the likelihood of their continued existence. The reservation of late-successional forest in National Parks and Wildernesses, land use plans, and our additional mitigations should contribute toward assuring viability of these species but the state of knowledge about these species is such that viability simply cannot be assessed. We strongly recommend processes be put in place to obtain and evaluate information necessary to evaluate viability of these species. However, we recognize that additional species can always be identified about which we know too little to assure viability. Many lower life forms have never been studied--species beyond our wide scope of inquiry.

Full implementation of the SAT mitigation strategy includes:

1. Retention of current National Forest plan standards and guidelines for Management Indicator Species, and Management Requirement Species (as described in approved Forest Management Plans) outside the areas within the range of the northern spotted owl where the standards and guidelines prepared herein are applicable. The land allocations that reduce timber harvest, preclude scheduled timber harvest, or call for no timber harvest in the Forest Land and Resource Management Plans and thereby ensure habitat for species associated with late-successional forests should not be reduced. The first step in the SAT's assessments of viability was to examine Forests Plans to evaluate how well they provided for late-successional, old-growth associated species. Other steps necessary to provide for species viability and ensure against extirpation were added. Alterations detracting from the value or amounts of these areas will increase risks to some unknown degree to viability for such species. Proposals for changes in Forest Plans that result in elimination or degradation of such habitat should be reviewed through an adaptive management process recommended and described below.

2. Implementation of any management strategy under the Supplemental EIS (being prepared by the Forest Service) that incorporates recommended additions to late-successional, old-growth forests to compensate for the higher risk associated with the preferred alternatives of BLM's draft resource management plans or another plan that has a "high viability rating" for the northern spotted owl. If, alternatively, the BLM opted for the Interagency Scientific Committee (ISC) option in their Draft Forest Management Plans or the Fish and Wildlife Service Draft Recovery Plans, no such mitigation would be necessary.

3. Implementation of SAT recommended standards and guidelines for other old-growth associated species. The SAT recognized that modifications to National Forest land management plans cannot be instantly accomplished while complying with requirements of NEPA and the National Forest Management Act (NFMA). The SAT believes that the suggested mitigations can best serve to enhance species viability if the mitigations are implemented in the soonest possible time while, of course, complying with applicable laws and regulations.

4. Consistent interpretation and application of SAT suggested standards and guidelines for other late-successional and old-growth forest associated species through a formally prescribed oversight process. This oversight process should be developed by Forest Service management and involvement of other appropriate Federal and State agencies.

5. Development of an adaptive management process as described below..

Ongoing Activities

We recognized that there are numerous ongoing activities on National Forests, some of which involve contracts, special-use permits, rights-of-way, leases, or other binding agreements. Some of the standards and guidelines, such as those for the Watershed Protection Areas and marbled murrelets (Chapter 6) have specific language addressing some of these ongoing activities. For the most part, though, we have not offered such specific recommendations, and offer the following:

Ongoing activities that do not involve contractual or otherwise binding agreements should be modified to be consistent with the standards and guidelines immediately upon implementation of those standards and guidelines.

Ongoing activities that involve contractual or other binding agreements and where the Forest Service retains discretionary authority for alterations, should be assessed to determine compatibility with the standards and guidelines. Where they conflict, consideration should be given to cancellation or modification.

Timber sales are recognized as a highly impactful activity upon old-growth forests and associated species. Current, prolonged injunctions against entering into new timber sale contracts have reduced the numbers of sold and awarded sales located in late-successional, old-growth habitats within the range of the northern spotted owl. We do not believe blanket cancellation of sales under contract is warranted. Each such activity should be individually evaluated. There are likely individual situations where cancellation and alteration maybe appropriate--especially timber sales, that may affect Federally listed species such as the marbled murrelet. We note that there are several reviews by the Forest Service and the Fish and Wildlife Service of ongoing activities being conducted as part of the Section 7 consultation process. Such consultation should provide a rigorous examination of these ongoing activities with suggested alterations where deemed appropriate.

Regulations promulgated pursuant to the Endangered Species Act (ESA) that require Federal agencies to avoid irretrievable or irreversible commitments of resources until consultation is concluded is an integral part of this assessment. Adherence to this provision in the regulations should allow adequate time for the site-specific analyses necessary to determine whether such projects are in compliance with those regulations and should proceed.

As discussed in Chapter 3, page ***, Section 7 consultation will not result in "de facto" recovery plans or conservation strategies with high probabilities of ensuring the viability of a threatened or endangered (i.e. "listed" species) species. In order to establish a standard higher than that of only avoiding jeopardy, the SAT recommends that, for Federally listed species, for which a recovery plan or conservation strategy has not been implemented, that; (1) not only the "Reasonable and Prudent Measures" or "Reasonable and Prudent Alternatives" presented in Biological Opinions by the Fish and Wildlife Service be followed as required by law, but that (2) the "Conservation Recommendations" made in such Biological Opinions be followed until the implementation of a

recovery plan or conservation strategy indicates they are not needed. Adoption of such Conservation Recommendations will likely result in interim protection levels adequate to ensure that ongoing agency activities will not seriously erode options essential to the development of credible recovery plans or conservation strategies.

Proposed or Planned Activities

Activities or projects that are in the proposal stage should be examined to see if modifications are necessary to comply with mitigations. If so, these activities or projects should be modified to meet the mitigation standards regardless of the stage of the planning.

Adaptive Management

The proposals we have offered as means to ensure against the loss of species viability or the extirpation of species are considered to be starting points. The SAT based recommendations on the best available information including the assistance of recognized experts and professional judgements of team members. The SAT believes that the mitigation measures, if fully implemented, have a high probability of success. We emphasize, however, that in time, additional information will become available that may well require re-examination of the suggested mitigation measures. Where and when new information warrants, changes in the proposed management should be made--a process known as "adaptive management". We have based much of the following discussion of adaptive management from a similar discussion by the Spotted Owl Recovery Team. A key priority in the adaptive management process should be consistent funding of research and monitoring programs. Without such research and monitoring effort, it will not be possible to appropriately document changes that would indicate the need for and the course of adaptive management.

The idea of adaptive management seems straightforward and simple--i.e., when better data become available, the standards and guidelines would be changed. However, such a process is very complex. There is often reluctance by organizations and individuals to alter decisions and practices that have become established. There may be uncertainty about the nature of the changes or the consequences--biological, sociological, political, and economic--of change. Questions may also arise about the appropriate timing of indicated change.

Development of a well-defined process of adaptive management can help alleviate some of these difficulties. Such a process provides a structure for dealing with new information in an orderly way and should produce rationally derived and well-documented recommendations for adaptation. The following 13 steps represent one possible process.

1. Describe the aspect of the set of mitigation measures being addressed and the nature of the objective that produced the original recommendation.
2. Describe the current standards and guidelines.

3. Describe the basis for the extant standards and guidelines--i.e., the specific information that was used in development and how that information was synthesized. It is important to separately consider: (1) information derived from specific studies; (2) interpretations of that information; or (3) assumptions; and (4) professional judgements.

4. Provide some assessment of the power or relative weight of the information used in developing the standards and guidelines. This should help in ascertaining if extant standards and guidelines require or should be changed. This process further suggests the types of information that should be collected in anticipation of changes.

5. Describe working hypotheses about how proposed changes in standards and guidelines will function to achieve objectives. This process may entail development of specific models for the elements being considered.

6. Describe clearly the anticipated outcomes if extant standards and guidelines are followed. These predictions should include ranges of possible outcomes based both on empirical observations, expert opinions, and the use of simulation models.

7. Describe possible outcomes if standards and guidelines do not function as expected. Such assessment should help establish the bases for identification of trigger points to determine when standards and guidelines should be reexamined.

8. Describe potential changes to the standards and guidelines if outcomes are not as predicted. Identification of such potential changes early in the process will allow time to institute research and management experiments to focus on components of extant standards and guidelines deemed most critical. This action would allow assessment of future options and the likelihood that those options would be put in place at some future time.

9. Describe the monitoring and research information that should be collected in order to: (1) Determine whether the standards and guidelines are being properly implemented; (2) Determine if the standards and guides are producing expected results; (3) Determine what changes to the standards and guidelines are appropriate; and (4) Define responsibilities and establish funding and specific plans to reach objectives of the standards and guides.

10. Describe the trigger points that set off reviews of and changes in standards and guidelines. There should be at least three types of such trigger points: (1) passage of time--i.e., regularly scheduled reviews; (2) outcomes are outside those parameters expected; and (3) new information that may be relevant to changed expected outcomes of application of the standards and guidelines.

11. When trigger points are reached, review monitoring and research data to determine if changes to the standards and guidelines are indicated. Risk assessment, focused on both the original decision and the forecast change, should be incorporated in making these decisions.

12. Make decisions and implement new standards and guidelines.

13. Initiate monitoring plans to assess whether the modification is achieving the desired results. Subject the new standards and guidelines to steps 1-12.

We recommend that an adaptive management process incorporating these, or some refinement of these steps be developed immediately upon implementation of new standards and guidelines for mitigation.

Ongoing Planning and Evaluations

The Forest Service, BLM, and the Fish and Wildlife Service have ongoing research, monitoring, and management activities that will produce new information on spotted owls, and old-growth species, and their habitats, for consideration through the adaptive management process. These efforts include Recovery planning by the Fish and Wildlife Service for northern spotted owls and marbled murrelets, and by the National Marine Fisheries Service for various stocks of anadromous fish; Status Reviews conducted by the Fish and Wildlife Service under requirements of the ESA; BLM Resource Management Planning; and the development of conservation strategies by the Forest Service for marbled murrelets, bull trout, forest owls, goshawk, furbearers, and Pacific anadromous fishes. Information from these and other efforts will need to be quickly and thoroughly processed through strict technical assessment and the adaptive management process to ascertain if and how the standards and guidelines put forth should be modified.

Research and Monitoring

Research and monitoring are essential components of adaptive management. It is likely that this information will add to the understanding of whether standards and guidelines are functioning as expected or whether change is warranted. Critical elements required for research and monitoring are: (1) Identification of critical monitoring or research questions for the species or standard and guideline in question. This includes implementation, effectiveness, and validation monitoring of standards and guidelines; (2) Describe appropriate inventory standards and protocols for the species in question; (3) Description of how variations in inventory standards will result in varying levels of reliability in estimates of population status and trend or trend in habitat condition; (4) Identification and coordination of interactions between monitoring and research programs.

Interagency Coordination

The Interagency Scientific Committee identified lack of interagency and intra-governmental cooperation as a longstanding, major obstacle of efforts to produce an effective, cost-efficient spotted owl plan. They expected such a problem to exist into the future. That condition does continue to exist. Added to the complexities of the management of the habitat of northern spotted owls, marbled murrelets, and anadromous fish are a myriad of other issues and considerations pertaining to the hundred of other species associated with older forest conditions. In order to ensure the best chances of success, the SAT believes it is essential that Federal and State agencies with responsibilities

in this area, develop a unified management strategy for old-growth and late-successional forest associated species. Efficiencies and opportunities not available to any single agency could be greatly enhanced by such an approach. It seems that the intertwined biological, economic, political, and social considerations make the absence of a unified approach increasingly difficult to either overcome or justify. The SAT mitigation strategy, for example, applies only to National Forests. But, population viability of the marbled murrelet and many fish stocks, for example are a function of habitat conditions on all types of ownerships most certainly on Federal lands. Conservation of rangewide habitat conditions for such species as the marbled murrelet and many of the fish stocks simply cannot be accomplished by one agency alone.

The SAT emphasizes the need to treat the proposed viability evaluations of late-successional and old-growth associated species and the proposed mitigation options as management hypotheses. All species that we identified as associated with old-growth, and particularly those identified as having a risk to their viability, require further research, monitoring of habitat amount and distribution and, in some cases, monitoring of specific population parameters such as distribution, size, and trend of population.

The SAT's effort is an initial step in a fuller process for providing underlying support to ecosystem management, planning, and evaluation. There is still much basic work required to support ecologically based land stewardship under a concept of ecosystem management. The SAT evaluated a complex array of species--including vertebrate, vascular and nonvascular plants, and invertebrates. This led to the proposal of a far-reaching management strategy that, in total, protects adequate habitat of all those species for which there is available information to guide such action. But, our approach emphasized focused the composition of old-growth forest ecosystems through a focus on plant and animal species associated with such habitats. The next step toward ecosystem management is anticipated to involve evaluation of ecological functions and processes as a means to design management strategies to achieve such goals as desired mixes of predators and prey, parasites and their hosts, or energy flow. Such approaches would lead away from a species-by-species approach and toward a desired state of ecosystem function which might, in turn, lead to sustainability of ecosystem components.

CHAPTER 8

ACKNOWLEDGEMENTS

CHAPTER 8

ACKNOWLEDGEMENTS

The Scientific Analysis Team gratefully acknowledges the outstanding contributions of the following people.

Panelists

Joe Ammirati
Robert Anthony
Keith Aubry
Ken Berg
Bruce Bingham
Andrew Blaustein
R. Bruce Bury
Andy Carey
P. Stephen Corn
Rex Crawford
John Cristy
Steve Cross
Bill Denison
Steve DeStefano
Fred Gilbert
Jim Hallot
Andy Hanson
Mark Huff

Lawrence L.C. Jones
Larry Irwin
Dave Manuwal
Dave Marshall
Kevin McGarlighal
Lisa McCrimmon
Chris McGuire
Charles Meslow
Gary Miller
Kim Nelson
Dan Norris
Dave Peter
Steve Rust
Keith Swindel
Jim Thrilkil
Hartwell Welsh
Cindy Zabel
Joan Ziegletrum

Technical Support

Melody Allen
Sandy Arbogast
Bruce Bingham
Ian Blackburn
Lisa Brown
Mark Brown
Amedee Brickey
Mark Brown
Esther Burkette
Greg Butcher
Kim Chipman
Sharon Clark
Warren Cohen
Bill Cunningham
Ken Denton
Ingreth Deyrup-Olsen
Nancy Diaz
Lowell Diller
Dave Dunbar
Karen Dvornich

Maria Fiorella
Tracy Flemming
Ray Forson
Larry Fox
Alan Franklin
Stanley C. Frazier
Eric Gillette
Gordon Gould
Pat Greenlee
Beth Gallaher
Eric Hanson
Mark Higley
Rob Horn
Larry Irwin
Cheryl Johnson
Richard E. Johnson
George Leinkaemper
Wayne Logan
Dean Longrie
Phil Maddocks

Technical Support (cont.)

Mary Maj
Robert Matroni
Kelly McAllister
Greg Miller
Kim Nelson
David M. Olson
Tom O'Niel
Bill Otani
Tom Owens
Kevin Peeler
Malcom Pious
Ann Potter
Janice Reid
Dennis Rock
Glen Sargeant
John Scharrard
Frances Schmechel
Erran Seaman
Gene Silovsky

Fred Seavey
Stan Sovern
Tom Spies
Janie Stenbach
John Steffenson
Marilyn Stoll
John Tappeiner
Jim Thraillkill
James Valenti
Frank Wagner
Teri Waldron
Thomas Wenk
Bill Wettengel
Jim White
Andy Wilson
Joe Witt
Kip Wright

Administrative Support

Sharon Alverts
Ann Arnold
Diana Bus
Mauragrace Healey
Linda Kucera

Pam Novitsky
Kay Pennell
Ayn Shlisky
Carol Tocco
Kristi Swisher

This project was brought to completion thanks to the significant contributions of:

Robert Anthony
Robin Leshner
PACFish Technical Committee:
 Gordon Grant
 Dennis Harr
 Robert Ziemer
The Xerces Society and David Olson
John Young
Joan Ziegltrum

*** DRAFT - WORKING DOCUMENT - NOT SUBJECT TO FOIA - DO NOT DUPLICATE ***

CHAPTER 9

GLOSSARY

CHAPTER 9

GLOSSARY

Most of the terms in this glossary were taken from the glossaries of the Interagency Scientific Committee's Conservation Strategy (ISC Report), the Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (FEIS), the U.S. Fish and Wildlife Service's Draft Recovery Plan for the Northern Spotted Owl (Draft Recovery Plan), or Alternatives for Management of Late-Successional Forests of the Pacific Northwest (Late-Successional Forests Report). Any remaining terms have been defined by the Scientific Analysis Team. The source of each definition appears at the end of the definition.

50-11-40 rule - a guideline developed by ISC to provide habitat conditions to facilitate movement of juvenile and adult owls across the landscape. It requires that 50 percent of the forest within a quarter-township be maintained with an average tree dbh of at 11 inches and 40 percent canopy closure. (Draft Recovery Plan)

100-year floodplain - the area adjacent to a stream which is on average inundated once a century. (Scientific Analysis Team)

Adaptive management - the process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans, and using the resulting information to improve the plans. (Draft Recovery Plan)

Age class - an interval, usually 10 to 20 years, into which the age ranges of vegetation are divided for classification or use. (FEIS)

Age specific birth rate - rate at which individuals of a particular age produce young. (Scientific Analysis Team)

Age specific survival rate - the average population of individuals in a particular age group that survive for a given time period. (Scientific Analysis Team)

Agreement areas - also BLM-ODFW agreement areas; spotted owl habitat areas protected by the BLM under a cooperative agreement with the ODFW. (ISC Report)

Allee effect - a depression in the encounter rate between males and females resulting from low population densities; the probability of finding a mate drops below that required to maintain the reproductive rates necessary to support the population. (ISC Report)

Allowable sale quantity (ASQ) - the quantity of timber that may be sold from the area of suitable land covered by a Forest Plan for a time period specified by the Plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity." (FEIS)

Alternative - one of several policies, plans, or projects proposed for decision making. (FEIS)

Anadromous fish - fish that are born in freshwater, rear there as immature, move to the ocean to grow and mature, and return to freshwater to reproduce. (Scientific Analysis Team)

Aquatic ecosystem - any body of water, such as a stream, lake, or estuary, and all organisms and non-living components, functioning as a natural system. (Late-Successional Forests Report)

Arboreal - living in the canopies of trees. (FEIS)

Aspect - the direction a slope faces with respect to the cardinal compass points. (Draft Recovery Plan)

Associated species - a species found to be numerically more abundant in a particular forest successional stage as compared to other stages (Ruggiero et al. 1991). (FEIS)

Awarded sales - Federal timber sales that have been let to the successful bidder through a formal contract. (ISC Report)

Biological diversity - the variety of life and its processes, including complexity of species, communities, gene pools, and ecological functions. (Draft Recovery Plan)

Biological opinion - the document resulting from formal consultation that states the opinion of the Fish and Wildlife Service or National Marine Fisheries Service as to whether or not a Federal action is likely to jeopardize the continued existence of listed species or results in destruction or adverse modification of critical habitat. (Scientific Analysis Team)

Block (of forest, habitat) - geographical area of trees or vegetation that is distinct from surrounding conditions. Block size may vary greatly. (Late-Successional Forests Report)

BLM - Bureau of Land Management, U.S. Department of the Interior.

Blowdown - trees felled by high winds. (Draft Recovery Plan)

Breast height - a standard height from average ground level for recording diameter, girth, or basal area, generally 4.5 feet (1.37 meters). (Draft Recovery Plan)

Broadcast burn - allowing a prescribed fire to burn over a designated area within well-defined boundaries for reduction of fuel hazard or as a silvicultural treatment, or both. (Draft Recovery Plan)

Buffer - used in the context of marbled murrelet standards and guidelines--a forested area located adjacent to suitable (nesting) marbled murrelet habitat that reduces dangers of having sharply contrasting edges of clearcuts next to such habitat. Dangers include risk of wind damage to nest trees and young, increased predation and loss of forest interior conditions. (Scientific Analysis Team)

Canopy - a layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage. Here it is used to describe lower layers, but over one's head, in a multistoried stand. (Scientific Analysis Team)

Canopy closure - the degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky. It can only be accurately determined from measurements taken under the canopy as openings in the branches and crowns must be accounted for. (Scientific Analysis Team)

Capability - the potential of an area of land to produce resources, supply goods and services, and allow resource uses. Capability depends upon current vegetation conditions and site conditions such as climate, slope, landform, soils, and geology. (Draft Recovery Plan)

Capture history - a record of the recaptures or resightings of a marked individual. Usually recorded as a string of 1's or 0's to indicate occasions when the individual was either recaptured or not recaptured. (Scientific Analysis Team)

Carrying capacity - the maximum number of organisms that can be supported in a given area of habitat at a given time. (FEIS)

Catastrophic event - a large-scale, high-intensity natural disturbance that occurs infrequently. (Late-Successional Forests Report)

Cavity nester - wildlife species, most frequently birds, that require cavities (holes) in trees for nesting and reproduction. (Late-Successional Forests Report)

Checkerboard ownership - a land ownership pattern in which every other section (square mile) is in Federal ownership as a result of Federal land grants to early western railroad companies. (ISC Report)

Classic old growth - forest stands with unusually old and very large trees that also meet criteria for old-growth forests; stands that meet the definition in Forest Service publication PNW-447. (Late-Successional Forests Report)

Clear-cut - an area where the entire stand of trees has been removed in one cutting. (Draft Recovery Plan)

Closely associated species - a species is designated as "closely associated" with a forest successional stage if the species is found to be significantly more abundant (based on statistical significant levels set in Ruggiero et al. 1991) in that forest successional stage as compared to the other successional stages, or if it is known to occur almost exclusively in that successional stage. (FEIS)

Cluster - an area that contains habitat capable of supporting three or more breeding pairs of spotted owls with overlapping or nearly overlapping home ranges. (Draft Recovery Plan)

Code of Federal Regulations (CFR) - a codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government. (FEIS)

Cohort - individuals all resulting from the same birth-pulse, and thus all of the same age. (ISC Report)

Commercial forest land - land declared suitable for producing timber crops and not withdrawn from timber production for other reasons. (Late-Successional Forests Report)

Commercial thinning - the removal of generally merchantable trees from an even-aged stand, usually to encourage growth of the remaining trees. (Late-Successional Forests Report)

Community - pertaining plant or animal species living in close association and interacting as a unit. (Late-Successional Forests Report)

Conferencing - informal consultation that takes place between the U.S. Fish and Wildlife Service and another federal agency when it is determined that a proposed federal action may jeopardize the continued existence of a species proposed as threatened or endangered or result in adverse modification of proposed critical habitat. (Draft Recovery Plan)

Conifer - a tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence coniferous) and needle-shaped or scale-like leaves. (Draft Recovery Plan)

Connectivity - a measure of the extent to which intervening habitat truly connects species reserves for juvenile spotted owls or other species dispersing among them. (Scientific Analysis Team)

Conservation - the process or means of achieving recovery or viable populations. (Scientific Analysis Team)

Conservation Recommendations - suggestions by the Fish and Wildlife Service or National Marine Fisheries Service in biological opinions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat. (Scientific Analysis Team)

Conservation strategy - a management plan for a species, group of species, or ecosystem that prescribes standards and guidelines which if implemented provide a high likelihood that the species, groups of species, or ecosystem, with its full complement of species and processes, will continue to exist well-distributed throughout a planning area i.e., a viable population. (Scientific Analysis Team)

Consultation - a formal interaction between the U.S. Fish and Wildlife Service and another federal agency when it is determined that the agency's action may

affect a species that has been listed as threatened or endangered or its critical habitat. (Draft Recovery Plan)

Contiguous habitat - habitat suitable to support the life needs of species that is distributed continuously or nearly continuously across the landscape. (Draft Recovery Plan)

Corridor - a defined tract of land, usually linear, through which a species must travel to reach habitat suitable for reproduction and other life-sustaining needs. (ISC Report)

Critical habitat - Under the Endangered Species Act, critical habitat is defined as "the specific areas within the geographic area occupied by a Federally listed species...on which are found those physical and biological features essential to the conservation of the species, and that may require special management considerations or protection; and specific areas outside the geographic area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species." (FEIS)

Critical link - In this report, geographical areas located between physiographic provinces that represent most likely avenues for dispersing spotted owls provided habitat conditions are favorable for such movement. (Scientific Analysis Team)

Crown - the upper part of a tree or other woody plant which carries the main system of branches and the foliage. (Draft Recovery Plan)

Crown closure - the degree to which the crowns of trees are nearing general contact with one another. Generally measured as the percent of the ground surface that would be covered by a vertical projection of foliage in the crowns of trees.

Crude density - the number of individuals in an area. (Scientific Analysis Team)

Cumulative effects - those effects on the environment which result from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. (FEIS)

CWD (coarse woody debris) - portion of a tree that has fallen or been cut and left in the woods. Usually refers to pieces at least 20 inches in diameter. (Draft Recovery Plan)

DBH - diameter at breast height. The diameter of a tree measured 4 feet 6 inches above the ground on the uphill side of the tree. (FEIS)

DCA - designated conservation area. (Draft Recovery Plan)

Debris torrent - rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods; generally occurs in

smaller streams and results in scouring of stream bed. (Late-Successional Forests Report)

Demographic model - a model that predicts the future state of an animal population based on its birth and death rates. (Draft Recovery Plan)

Demographic stochasticity - random fluctuations in birth and death rates. (ISC Report)

Demography - the quantitative analysis of population structure and trends; population dynamics. (Draft Recovery Plan)

Density, biological population - the number or size of a population in relation to some unit of space. It is usually expressed as the number of individuals or the population biomass per unit area or volume. (Draft Recovery Plan)

Density-dependent - a process, such as fecundity, whose value depends on the number of animals in the population per unit area. (ISC Report)

Density management - In Bureau of Land Management Draft planning documents of 1992--cutting trees for the primary purpose of widening their spacing so that growth of remaining trees can be accelerated. Density management can also be used to improve forest health, to open the forest canopy or to accelerate the attainment of old-growth characteristics if maintenance or restoration of biological diversity is the objective. (Scientific Analysis Team)

Density study area - an area in which the objective is to count all individuals that are present, thereby monitoring populations trends over time. (Scientific Analysis Team)

Designated conservation area (DCA) - a contiguous area of habitat to be managed and conserved for spotted owls. This general description can be applied to two categories:

DCA 1 - category of DCA intended to support at least 20 pairs of spotted owls.

DCA 2 - category of DCA intended to support one to 19 pairs of spotted owls. (Draft Recovery Plan)

Desired future conditions - an explicit description of the physical and biological characteristics of a habitat type believed necessary to meet objectives for a species. (Late-Successional Forests Report)

Dispersal - the movement, usually one way and on any time scale, of plants or animals from their point of origin to another location where they subsequently produce offspring. (Late-Successional Forests Report)

Dispersal capability - the ability of members of a species to move from their area of birth to another suitable location and subsequently breed. (Draft Recovery Plan)

Dispersal distance - a straight-line distance that an individual travels from its birth place until it stops dispersing (assumed to be a breeding site) or dies. (ISC Report)

Dispersal habitat - habitat that supports the life needs of an individual animal during dispersal. Generally satisfies needs for foraging, roosting, and protection from predators. (Draft Recovery Plan)

Distribution (of a species) - the spatial arrangement of a species within its range. (Draft Recovery Plan)

Disturbance - a significant change in structure and/or composition caused by natural events such as fire and wind or human-caused events such as cutting. (Draft Recovery Plan)

Diversity - the variety, distribution, and abundance of different plant and animal communities and species within an area. See biological diversity. (FEIS)

Down log - portion of a tree that has fallen or been cut and left in the woods. (Draft Recovery Plan)

Draft Environmental Impact Statement (DEIS) - the draft statement of environmental effects which is required for major Federal action under Section 102 of the National Environmental Policy Act, and released to the public and other agencies for comment and review. (FEIS)

Drainage - a large area mostly bounded by ridges, encompassing part, most or all of a watershed and enclosing on the order of 5,000 acres. (Late-Successional Forests Report)

Duff layer - the layer of loosely compacted debris underlying the litter layer on the forest floor.

Early seral stage forests - stage in forest development that includes seedling, sapling, and pole-sized trees. (Draft Recovery Plan)

East-side forests = the 12 National Forests in Washington, Oregon, and California that lie partly or wholly east of the Cascade Mountain Range crest: Colville, Deschutes, Fremont, Klamath, Malheur, Ochoco, Okanogan, Shasta-Trinity, Umatilla, Wallowa-Whitman, Wenatchee, and Winema National Forest. (Draft Recovery Plan)

Ecological health - the state of an ecosystem in which processes and functions are adequate to maintain diversity of biotic communities commensurate with those initially found there. (Late-Successional Forests Report)

Ecosystem - an interacting system of organisms considered together with their environment; for example, marsh, watershed, and lake ecosystems. (Draft Recovery Plan)

Ecosystem approach - a strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species. (Late-Successional Forests Report)

Edge - where plant communities meet or where successional stages or vegetative condition with plant communities come together. (Draft Recovery Plan)

Edge effect - the effect of adjoining vegetative communities on the population structure along the margin, which often provides for greater number of species and higher population densities of some species than either adjoining community. Edge may result in negative effects as well; habitat along an edge is different than in the patch of habitat, reducing the effective area of the habitat patch. (FEIS)

Emigration - permanent movement of individuals of a species from a population. (ISC Report)

Empirical - derived from direct observation or experimentation. (Draft Recovery Plan)

Endangered species - any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range; plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act. (Draft Recovery Plan)

Endemic - a species that is unique to a specific locality. (Draft Recovery Plan)

Environmental stochasticity - random variation in environmental attributes such as temperature, precipitation, and fire frequency. (Draft Recovery Plan)

Epiphyte - a plant that grows upon another plant and that is nonparasitic. Most of the plant's necessary moisture and nutrients are derived from the atmosphere. (Draft Recovery Plan)

Even-aged forest - a forest stand composed of trees with less than a 20-year difference in age. (Draft Recovery Plan)

Even-aged management - the application of a combination of actions that result in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the forest area. The difference in age among trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for harvesting. Clear-cut, shelterwood, or seed tree cutting methods produce even-aged stands. (Draft Recovery Plan)

Extended rotation - a period of years that is longer than the time necessary to grow timber crops to a specific condition of maturity. (Draft Recovery Plan)

Extinct - a species is extinct when it no longer exists. (Draft Recovery Plan)

Extirpation - the elimination of a species from a particular area. (Draft Recovery Plan)

Extirpation risk species - in this report, those species that were generally ranked as having a medium low or low viability over a 50-year period under one FEIS alternative. Extirpation related to local extinction of a species from one or more National Forests within the range of the northern spotted owl.

F1 cross - offspring resulting from a cross between two original parental stocks. (Scientific Analysis Team)

Fecundity - number of female young produced per adult female. (ISC Report)

Final Environmental Impact Statement (FEIS) - the final version of the statement of environmental effects required for major Federal actions under Section 102 of the National Environmental Policy Act. It is a revision of the draft environmental impact statement to include public and agency responses to the draft. (FEIS)

Fire regime - the characteristic frequency, extent, intensity, severity, and seasonality of fires in an ecosystem. (Draft Recovery Plan)

Fledge - to rear until ready for flight or independent activity. (Draft Recovery Plan)

Floater - nonbreeding adults and subadults that move and live within a breeding population, often replacing breeding adults that die; nonterritorial individuals. (Draft Recovery Plan)

Forest or Forest land - lands currently supporting or capable of supporting forests at a density of 10 percent crown closure or better.
[Forest land - at least 10 percent land area covered by forest trees or formerly having had such tree cover and not currently developed for other use. (Late-Successional Forests Report)]

Forest fragmentation - the change in the forest landscape, from extensive and continuous forests of old-growth to a mosaic of younger stand conditions. (Draft Recovery Plan)

Forest landscape - land presently forested or formerly forested and not currently developed for nonforest use. (ISC Report)

Forest matrix - forest lands between designated areas managed primarily for spotted owl habitat. (FEIS)

Forest plan - a land management plan designed and adopted to guide forest management activities on a National Forest or BLM District. (Late-Successional Forests Report)

Fragmentation - the process of reducing size and connectivity of stands that comprise a forest. (FEIS)

FWS - Fish and Wildlife Service, U.S. Department of the Interior.

GIS - geographical information system. This is a computer system capable of storing and manipulating spatial (i.e., mapped) data. (Draft Recovery Plan)

Green tree - a live and growing tree. (Late-Successional Forests Report)

Green-tree retention - the silvicultural practice of retaining live, growing trees on a site during timber harvest as a future source of snags. (Late-Successional Forests Report)

Guideline - a policy statement that is not a mandatory requirement (as opposed to a standard, which is mandatory). (Draft Recovery Plan)

HA (hectare) - a measure of area in the metric system equal to approximately 2.5 acres. (Draft Recovery Plan)

Habitat - the place where a plant or animal naturally or normally lives and grows. (Draft Recovery Plan)

Habitat capability - the estimated number of pairs of spotted owls that can be supported by the kind, amount, and distribution of suitable habitat in the area. As used in the recovery plan, this means the same as capability to support spotted owl pairs. (Draft Recovery Plan)

Hard snag - a recently dead standing tree that typically still has an intact top, a high degree of bark cover, and most limbs; hard snags are required by a number of wildlife species, including cavity nesters. (Late-Successional Forests Report)

Harvest cutting method - methods used to harvest trees. Harvest cutting methods are classified as even-aged and uneven-aged. (Draft Recovery Plan)

HCA (habitat conservation area) - as proposed by the Interagency Scientific Committee, a contiguous block of habitat to be managed and conserved for breeding pairs, connectivity, and distribution of owls; application may vary throughout its range according to local conditions. (Draft Recovery Plan)

Helicopter logging - use of helicopters to transport logs from where they are felled to a landing. (Scientific Analysis Team)

High-lead cable system - a harvest technology where cut logs are suspended above the ground and transported to a landing. (Scientific Analysis Team)

High viability risk species - in this report, those species that were generally ranked as less than high or medium high viability over a 50-year period under at least one FEIS alternatives.

Home range - the area within which an animal conducts its activities during a defined period of time. (Draft Recovery Plan)

Home range of a pair - the sum of the home ranges of each member of a pair minus the area of home range overlap. (Draft Recovery Plan)

Hybrid - an offspring that results from the mating of individuals of different races or species. (Draft Recovery Plan)

Hybridization - the crossing or mating of two different varieties of plants or animals. (Draft Recovery Plan)

Immigration - movement of individuals into a population. (Draft Recovery Plan)

Inbreeding - mating or crossing of individuals more closely related than average pairs in the population. (FEIS)

Incidental take - "take" of a threatened or endangered species that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. (FEIS)

Ingrowth - the period in time after successional growth of a forest stand when it reaches a specified age or structure class, for instance, spotted owl foraging habitat. (FEIS)

Inholding - land belonging to one landowner that occurs within a block of land belonging to another. For example, small parcels of private land that occur inside National Forests. (Draft Recovery Report)

Inner gorge - a stream reach bounded by steep valley walls which terminate upslope into a more gentle topography. Common in areas of rapid stream downcutting or uplift, such as northern California and southwestern Oregon. (Scientific Analysis Team)

Interdisciplinary team - a group of individuals with varying areas of specialty assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to adequately analyze the problem and propose action. (FEIS)

Interim (short-term) solution - a 2- to 4-year period. (Late-Successional Forests Report)

Interspecific - occurring among members of different species. (Draft Recovery Plan)

Interspecific competition - the condition of rivalry that exists when a number of organisms of different species use common resources that are in short supply; or, if the resources are not in short supply, the condition that occurs when the organisms seeking that resource nevertheless harm one or another in the process. Competition usually is confined to closely related species that eat the same sort of food or live in the same sort of place. Competition typically results in ultimate elimination of the less effective organism from that ecological niche. (Draft Recovery Plan)

Intraspecific - occurring among members of single species. (Draft Recovery Plan)

ISC (Interagency Scientific Committee) - a committee of scientists that was established by the U.S. Forest Service, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service, to develop a conservation strategy for northern spotted owls. (Draft Recovery Plan)

ISODATA Clustering - Iterative Self Organizing Data Analysis Technique, a statistical clustering technique that assigns spectral reflectance values to groups based on spectral distance between pairs of observations. This technique operates in an iterative fashion to optimize the statistical separation between groups. (Scientific Analysis Team)

Isolate - a population that is isolated. See isolation. (Draft Recovery Plan)

Isolation - absence of genetic crossing among populations because of distance or geographic barriers. (Draft Recovery Plan)

Jeopardy - a finding made through consultation under the Endangered Species Act that the action of a federal agency is likely to jeopardize the continued existence of a threatened or endangered species. (Draft Recovery Plan)

Jolly seber models - a group of mathematical models designed to estimate survival rates of organisms that are marked and then recaptured or reobserved on subsequent occasions. (Scientific Analysis Team)

Juvenile - for spotted owls, a juvenile is normally considered to be any bird that is less than 1 year old. (Scientific Analysis Team)

Key watershed - as defined by National Forest and BLM District fish biologists, a watershed contain (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than 6 square miles with high-quality water and fish habitat. (Late-Successional Forests Report)

Lambda - the finite rate of population change (population size in year 2 divided by the population size in year 1). (ISC Report)

Land allocation - the specification in Forest Plans of where activities, including timber harvest, can occur on a National Forest or BLM District. (Late-Successional Forests Report)

Landsat - a satellite that produces imagery used in remote sensing of forests. Analysis of this imagery produces maps of vegetation condition. (Draft Recovery Plan)

Landsat MSS - Landsat Multispectral Scanner, a satellite borne sensor, first launched in 1972, capable of recording reflected energy from the surface of the earth in four wavelength "bands" or divisions of the visible and infrared spectrum. The sensor records reflectance in the green, red, and near infrared portions of the spectrum as numeric "reflectance values" for a 180x180 km scene which is useful for mapping natural resources. (Scientific Analysis Team)

Landsat TM - Landsat Thematic Mapper, an improved version of the Landsat MSS satellite sensor capable of recording reflected and emitted energy from the surface of the earth in seven "bands" or divisions of the visible and infrared spectrum. First launched in 1982, this sensor has improved spatial resolution and finer tuning of the spectral wavelengths for specific application to forestry, geology, agriculture, and water resource studies. (Scientific Analysis Team)

Leave strips - generally narrow bands of forest trees that are left along streams and rivers to buffer aquatic habitats from upslope forest management activities. (ISC Report)

Litter layer - the loose, relatively undecomposed organic debris on the surface of the forest floor made up typically of leaves, bark, small branches, and other fallen material. (FEIS)

Long term - here, 50 to 100 years and sometimes beyond. (ISC Report)

Managed forest - forest land that is harvested on a scheduled basis and contributes to an allowable sale quantity. (ISC Report)

Management prescription - the management practices and intensity selected and scheduled for application on a specific area to attain multiple-use and other goals and objectives. (Draft Recovery Plan)

Marginal spotted owl habitat - vegetative communities, usually forest stands, that may provide for spotted owl life needs at least intermittently. Other times, depending on other environmental factors, the life needs of spotted owls would not be met. A landscape with a predominance of marginal habitat would not be thought to sustain a viable population of spotted owls. (Scientific Analysis Team)

Matrix - land within the range of the northern spotted owl that lies outside of category 1 and 2 Habitat Conservation Areas. (Scientific Analysis Team)

Mature stand - a mappable stand of trees for which the annual net rate of growth has culminated. Stand age, diameter of dominant trees, and stand structure at maturity vary by forest cover types and local site conditions. Mature stands generally contain trees with a smaller average diameter, less age class variation, and less structural complexity than old-growth stands of the same forest type. Mature stages of some forest types are suitable habitat for spotted owls; however, mature forests are not always spotted owl habitat, and spotted owl habitat is not always mature forest. (Draft Recovery Plan)

Maximum Likelihood Classification - A statistical classification technique which assigns reflectance values to groups based on the probability that an observation belongs to a particular class. (Scientific Analysis Team)

Mean - a central value of a series or set of observations obtained by dividing the sum of all observations by the number of observations. (Draft Recovery Plan)

Merchantable (trees, stands, timber) - trees or stands that people will buy for the wood they contain. (Late-Successional Forests Report)

Mesic - pertaining to or adapted to an area that has a balanced supply of water. Neither wet nor dry. (Draft Recovery Plan)

Meta-analysis - a method or analysis that simultaneously examines multiple sets of data from different subsets of a population to determine if there are any general trends in the population. (Scientific Analysis Team)

Meta-population - a population comprised of a set of local populations that are linked by migrants, allowing for recolonization of unoccupied habitat patches after local extinction events. (ISC Report)

Microenvironment - the sum total of all the external conditions that may influence organisms and that come to bear in a small or restricted area. (ISC Report)

Microhabitats - a restricted set of distinctive environmental conditions that constitute a small habitat, such as the area under a log. (ISC Report)

Minimum viable population - the low end of the viable population range. (Draft Recovery Plan)

Mitigation - mitigation includes: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensation for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20). (FEIS)

Mixed conifer - as used in this document, the term "mixed conifer" refers to stands of trees, made up of pine, Douglas-fir, and true firs, that are generally found east of the Cascades. (Draft Recovery Plan)

Mixed-conifer forest - a forest community that is dominated by two or more coniferous species. (Draft Recovery Plan)

Mixed-evergreen forest - a forest community that is dominated by two or more species of broad-leaved hardwoods whose foliage persists for several years: important western species include madrone, tanoak, chinquapin, canyon live oak, and California-laurel. (Draft Recovery Plan)

Model - an idealized representation of reality developed to describe, analyze, or understand the behavior of some aspect of it; a mathematical representation of the relationships under study. The term model is applicable to a broad class of representations, ranging from a relatively simple qualitative description of a system or organization to a highly abstract set of mathematical equations. (Draft Recovery Plan)

Monitoring - a process of collecting information to evaluate whether objectives of a management plan are being realized. (FEIS)

Monitoring program - see "monitoring;" the program used to monitor a population and its habitat. (ISC Report)

Movement - shifts in locations of animals, which may be two-way such as seasonal movements, or one-way as in a shift to a new breeding territory. (FEIS)

Multiple use - the management of renewable resources so that they are utilized in the combination that will best meet the needs of people. (Draft Recovery Plan)

Multistoried - term applied to forest stands that contain trees of various heights and diameter classes and therefore support foliage at various heights in the vertical profile of the stand. (Draft Recovery Plan)

Natal area - the location where an animal was born. (Draft Recovery Plan)

National Environmental Policy Act (NEPA) - an Act passed in 1969 to declare a National policy that encourages productive and enjoyable harmony between humankind and the environment, promotes efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, enriches the understanding of the ecological systems and natural resources important to the Nation, and establishes a Council on Environmental Quality (The Principal Laws Relating to Forest Service Activities, Agric. Handb. 453. USDA Forest Service, 359p.). (FEIS)

National Forest Management Act (NFMA) - a law passed in 1976 as an amendment to the Forest and Rangeland Renewable Resources Planning Act, requiring the preparation of Forest Plans and the preparation of regulations to guide that development. (FEIS)

NEPA - National Environmental Policy Act of 1969. (ISC)

Nesting, roosting, and foraging habitat - the forest vegetation with the age class, species of trees, structure, sufficient area, and adequate food source to meet some or all of the life needs of the northern spotted owl. (FEIS)

NF - National Forest. (Draft Recovery Plan)

Nocturnal - referring to organisms that are active or functional at night. (Draft Recovery Plan)

Nominal Resolution - the stated limit to the level of detail a given sensor can record. Usually this refers to spatial resolution or the smallest land area or object which can be discerned from satellite imagery. (Scientific Analysis Team)

Northern spotted owl - one (Strix occidentalis caurina) of three subspecies of the spotted owl which ranges from southern British Columbia, Canada, through western Washington and Oregon, and into northwestern California; listed as a threatened species by the U.S. Fish and Wildlife Service. (Late-Successional Forests Report)

Occupancy rate - in reference to spotted owls, the percent of inventoried spotted owl habitat that is estimated to be occupied by breeding pairs of spotted owls. (Draft Recovery Plan)

OGEA - In Bureau of Land Management Draft Planning Documents of 1992--Old Growth Emphasis Areas. Areas where management emphasis will be given to providing for old-growth associated species and biological diversity. Management would provide for timber production when consistent with local and landscape level diversity. (Scientific Analysis Team)

Old-growth - a forest stand with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; a high

incidence of large trees with large, broken tops, and other indication of decadence; numerous large snags; and heavy accumulations of logs and other woody debris on the ground. (Draft Recovery Plan)

Old-growth associated species - plant and animal species that exhibit a strong association with old-growth forests. (Draft Recovery Plan)

Old-growth stand - a mappable area of old-growth forest. (Draft Recovery Plan)

Overstory - trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage. (Draft Recovery Plan)

Owl site - any site where there has been a recent or historic observation of a single spotted owl or a pair of owls. (Draft Recovery Plan)

Packing - a temporary influx of organisms of various sex and age classes into remaining suitable habitat as previously available habitat is changed to unsuitable conditions. (FEIS)

Pair site - an amount of habitat that is considered capable of supporting one pair of spotted owls. (Draft Recovery Plan)

Patch - a small (20-60 acre) part of the forest. This term is often used to indicate a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across the landscape. (Late-Successional Forests Report)

Physiographic province - a geographic region in which climate and geology have given rise to a distinct array of landforms. Biology and habitat relationships of spotted owls vary by physiographic province due to differences in climate, vegetation, and productivity of habitats. (Draft Recovery Plan)

Pixel - abbreviated form of "Picture Element", or the smallest division of a picture or image. (Scientific Analysis Team)

Planning area - in this document, the range of the northern spotted owl on National Forests. (FEIS)

Platform nest - a relatively flat nest constructed on a supporting structure such as a broad branch. (Draft Recovery Plan)

Population density - number of individuals of a species per unit area. (Draft Recovery Plan)

Population dynamics - the aggregate of changes that occur during the life of a population. Included are all phases of recruitment and growth, senility, mortality, seasonal fluctuation in biomass, and persistence of each year class and its relative dominance, as well as the effects that any or all of these factors exert on the population. (Draft Recovery Plan)

Population viability - probability that a population will persist for a specified period of time across its range despite normal fluctuations in population and environmental conditions. (FEIS)

Population viability models - a mathematical abstraction of a system that is designed to predict the likelihood of persistence of a population under different conditions. (Scientific Analysis Team)

Potential habitat - a stand of trees of a vegetation type used by spotted owls that is not currently suitable, but is capable of growing or developing into suitable habitat in the future. In general, potential habitats are stands in the earlier successional stages of forest types used by spotted owls. (Draft Recovery Plan)

Precommercial thinning - the practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster. (Draft Recovery Plan)

Predator - any animal that preys externally on others, i.e., that hunts, kills, and generally feeds on a succession of hosts, i.e., the prey. (Draft Recovery Plan)

Prescribed burning - controlled fire deliberately set to meet various resource objectives. (Late-Successional Forests Report)

Prescribed fire - a fire burning under specified conditions that will accomplish certain planned objectives. The fire may result from planned or unplanned ignitions. (Draft Recovery Plan)

Presuppression - activities organized in advance of fire occurrence to ensure effective suppression action. (Draft Recovery Plan)

Protective management - measures taken by nonfederal entities to conserve spotted owls and or their habitat; measures may include participation in conservation planning (as defined in Endangered Species Act section 10) or other actions that benefit owls; entities may be states, private landowners, Indian tribes, or others. (Draft Recovery Plan)

Province - see physiographic province. (Draft Recovery Plan)

Quarter-township - an area approximately 3 miles square containing nine sections of land. (Draft Recovery Plan)

Radio-telemetry - automatic measurement and transmission of data from remote sources via radio to a receiving station for recording and analysis. In this recovery plan, it refers to the tracking of spotted owls by means of small radio transmitters attached to them. (Draft Recovery Plan)

Random - being or relating to a set or to an element of a set each of whose elements has equal probability of occurrence; also characterized by procedures to obtain such sets or elements. (Draft Recovery Plan)

Range (of a species) - the area or region over which an organism occurs. (Draft Recovery Plan)

Reasonable and prudent alternatives - alternative actions identified during formal consultation and communicated via a biological opinion, that can be implemented to avoid the likelihood of jeopardizing the continued existence of

listed species or destruction or adverse modification of critical habitat. (Scientific Analysis Team)

Reasonable and prudent measures - these actions the Fish and Wildlife Service or the National Marine Fisheries Service believe are necessary to appropriate to minimize the impacts i.e. amount or extent, or incidental take. These are communicated to a Federal agency in a biological opinion. (Scientific Analysis Team)

Record of Decision - a document separate from but associated with an environmental impact statement which states the management decision, identifies all alternatives including both the environmentally preferable and preferred alternatives, states whether all practicable means to avoid environmental harm from the preferred alternative have been adopted, and if not, why not. (FEIS)

Recovery - action that is necessary to reduce or resolve the threats that caused a species to be listed as threatened or endangered. (Draft Recovery Plan)

Recovery plan - a management plan developed under the authority of the Endangered Species Act which set forth management standards and population or other biological objectives for listed species. Implementation of such plans has a high likelihood that the species population and or distribution will improve to the point listing is no longer appropriate. (Scientific Analysis Team)

Rectification - the process of making imagery conform to a map projection system, usually to assign real world coordinates to image data. (Scientific Analysis Team)

Recruitment - the addition to a population from all causes, i.e., reproduction, immigration, and stocking. Recruitment may refer literally to numbers born or hatched or to numbers at a specified stage of life such as breeding age or weaning age. (Draft Recovery Plan)

Recruitment habitat - in this report pertaining to marbled murrelet mitigation--younger forest stands that presently do not have the attributes (large old-growth trees) of suitable marbled murrelet habitat but are expected to gain them through time. Protection of these stands will preserve the option to include them in a conservation strategy or recovery plan for marbled murrelets. (Scientific Analysis Team)

Reforestation - the natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial restocking. (Draft Recovery Plan)

Refugia - havens of safety where populations have high probability of surviving periods of adversity. (ISC Report)

Regeneration - the actual seedlings and saplings existing in a stand; or the act of establishing young trees naturally or artificially. (Draft Recovery Plan)

Region - a Forest Service administrative unit. The two Regions affected by this proposed action are the Pacific Northwest Region (Region 6) which includes National Forests in Oregon and Washington, and the Pacific Southwest Region (Region 5) which includes National Forests in California. (FEIS)

Region 5 - the National Forests of California; the Forest Service's Pacific Southwest Region. (Late-Successional Forests Report)

Region 6 - the National Forests of Washington and Oregon; the Forest Service's Pacific Northwest Region. (Late-Successional Forests Report)

Regional Forester - the Forest Service official responsible for administering a single Region. (FEIS)

Regional Guide - the guide developed to meet the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (NFMA). Regional Guides provide standards and guidelines for addressing major issues and management concerns which need to be considered at the regional level to facilitate Forest planning. (FEIS)

Regulations - generally refers to the Code of Federal Regulations. (Draft Recovery Plan)

Research Natural Area (RNA) - an area set aside by a public or private agency specifically to preserve a representative sample of an ecological community, primarily for scientific and educational purposes. In Forest Service usage, Research Natural Areas are areas designated to ensure representative samples of as many of the major naturally-occurring plant communities as possible. (FEIS)

Reserved land - lands that have been removed from the acreage base used to calculate timber yields. These lands often have a preservation or protection status. Wildernesses, research natural areas, and national recreation areas are examples of reserved lands. (Draft Recovery Plan)

Residual stand - the trees that remain standing after some event such as selection cutting. (Draft Recovery Plan)

Riparian area - geographically delineated areas with distinctive resource values and characteristics that are comprised of aquatic ecosystems, and ecosystems influenced by adjacent bodies of water. (FEIS)

Risk analysis - a qualitative assessment of the probability of persistence of wildlife species and ecological systems under various alternatives and management options; generally also accounts for scientific uncertainties. (Late-Successional Forests Report)

Risk-analysis scale - a continuum of values (from low through high) describing the likelihood that habitat for associated wildlife species and fish will persist. (Late-Successional Forests Report)

Roost - the resting behavior of an animal. (Draft Recovery Plan)

Roost sites - a site where an animal roosts. Can refer to daytime and nighttime roosting. Sites often provide protection from environmental conditions and from predators. (Draft Recovery Plan)

Rotation - the planned number of years between the regeneration of an even-aged stand and its final cutting at a specified stage. (Draft Recovery Plan)

Sanitation - the removal of dead or damaged trees, or trees susceptible to insect and disease attack such as intermediate and suppressed trees, essentially to prevent the spread of pest or pathogens to promote forest health. (FEIS)

Sapling - a loose term for a young tree no longer a seedling but not yet a pole. It is generally a few feet high and 2 to 4 inches dbh, typically growing vigorously and without dead bark or more than an occasional dead branch. (Draft Recovery Plan)

Second-growth - relatively young forests that have developed following a disturbance (for example, wholesale cutting, serious fire, or insect attack) of the previous old-growth forest.

[Second growth (FEIS) - forest growth that has become established following some interference, such as cutting, serious fire, or insect attack, with the previous forest crop.

Section 7 - the section of the Endangered Species Act that specifies the roles of interagency coordination in accomplishing the objective of species recovery. (Draft Recovery Plan)

Selection cutting - the annual or periodic removal of trees (particularly mature trees), individually or in small groups, from an uneven-aged forest, to realize yield and establish a new crop of irregular constitution. (FEIS)

Senescence - the process of aging. In demographic studies the usual concern is whether demographic rates change as organisms grow older. (Scientific Analysis Team)

Sensitive fish species and stocks - fish species and stocks (genetically distinct populations) of anadromous salmonids identified by the American Fisheries Society's Endangered Species Committee as needing special management considerations to avoid extinction. (Late-Successional Forests Report)

Sensitive species - those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a significant current or predicted downward trend in population numbers or density; or a significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution (FSM 2670.5(19)). (FEIS)

Seral - a biotic community that is a developmental, transitory stage in an ecological succession. (Draft Recovery Plan)

Seral species - species associated with an early stage in the development of a biotic community. (Draft Recovery Plan)

Shelterwood - an even-aged silvicultural system in which the old forest is removed in two or more successive cuttings. (Draft Recovery Plan)

Short term - here, 1 to 50 years. (ISC Report)

Silvicultural practices (or treatments) - the set of field techniques and general methods used to modify and manage a forest stand over time to meet desired conditions and objectives. (Late-Successional Forests Report)

Silviculture - the science and practice of controlling the establishment, composition, and growth of forests. (Draft Recovery Plan)

Simulation - the use of a computer or mathematical model to predict effects from a management scenario not yet enacted. (Late-Successional Forests Report)

Site-potential tree - a tree that has attained the maximum height possible given site conditions where it occurs.

[Site-potential tree - a tree located near a stream that is tall enough to reach the edge of the stream if it falls.]

Site productivity - the ability of a geographic area to produce biomass, as determined by conditions (e.g., soil type and depth, rainfall, temperature) in that area. (Late-Successional Forests Report)

Slash - the residue left on the ground after timber cutting. It includes unused logs, uprooted stumps, broken or uprooted stems, branches, twigs, leaves, bark, and chips. (Draft Recovery Plan)

Snag - a standing dead tree. (Draft Recovery Plan)

SOHA (spotted owl habitat area) - a habitat area designated to support one pair of owls. Such areas were prescribed in some previous plans for northern spotted owl conservation. (Draft Recovery Plan)

Spatially explicit model - a model that predicts the future state of an animal population based on mapped locations of organisms and their habitat. (Scientific Analysis Team)

Species - 1) a group of individuals that have their major characteristics in common and are potentially interfertile. 2) the Endangered Species Act defines species as including any species or subspecies of plant or animal. Distinct populations of vertebrates also are considered to be species under the act. (Draft Recovery Plan)

Spectral Class - A statistical grouping of similar spectral reflectance values from a satellite sensor which can be associated with a specific land cover class (i.e., forest, agriculture, water). (Scientific Analysis Team)

Spectral signature - specific combination of wavelengths of light energy reflected or radiated from a land surface, or, in forestry, a wavelength combination that more or less characterizes a specific forest condition or successional stage. (ISC Report)

Stage Classes - any distinguishable phase of growth or development of an organism. (FEIS)

Staggered setting - an approach to timber harvesting in which harvest units, separated by uncut units of at least the same size, are scattered across the landscape. (Late-Successional Forests Report)

Stand (tree stand) - an aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition as to be distinguishable from the forest in adjoining areas. (Draft Recovery Plan)

Stand condition - a description of the physical properties of a stand such as crown closure or diameters. (Draft Recovery Plan)

Stand-replacing event - a disturbance that is severe enough over a large enough area (for example, 10 acres) to virtually eliminate an existing stand of trees and initiate a new stand. (Draft Recovery Plan)

Standards and guidelines - principals specifying conditions or levels of environmental quality to be achieved. (FEIS)

Stochastic - random, uncertain; involving a random variable. (Draft Recovery Plan)

Stochastic model - a model that includes representation of random events. (Draft Recovery Plan)

Stocking - the degree of occupancy of an area of land by trees as measured by basal area or number of trees and as compared to stocking standard; that is, the basal area or number of trees required to fully use the growth potential of the land. (Draft Recovery Plan)

Structural diversity - the diversity of forest structure, both vertical and horizontal, which provides for a variety of forest habitats, such as logs and multilayered forest canopy, for plants and animals. (FEIS)

Structure - the various horizontal and vertical physical elements of the forest. (Late-Successional Forests Report)

Subadult - for spotted owls, a subadult is normally considered to be any individual that is 1-2 years old.

Subpopulation - a well-defined set of interacting individuals that comprise a proportion of a larger, interbreeding population. (ISC Report)

Subspecies - a population of species occupying a particular geographic area, or less commonly, a distinct habitat, capable of interbreeding with other populations of the same species. (Draft Recovery Plan)

Successional stage - a stage or recognizable condition of a plant community that occurs during its development from bare ground to climax; for example, coniferous forests in the Blue Mountains progress through six recognized stages: grass-for; shrub-seedling; pole-sapling; young; mature; old-growth. See also Seral. (Draft Recovery Plan)

Suitable habitat - the biological and physical components necessary to meet some or all the life needs of a species. (Draft Recovery Plan)

Suitable spotted owl habitat - See nesting, roosting, and foraging habitat. (Draft Recovery Plan)

Superspecies - two closely related species that are believed to have diverged relatively recently. (Scientific Analysis Team)

Superior habitat - habitat selected in excess of availability by the majority of individual northern spotted owls. (Draft Recovery Plan)

Suppression - the action of extinguishing or confining a fire. (Draft Recovery Plan)

Survival rate - the average population of individuals in a sample or a population that survive for a given time period. (Scientific Analysis Team)

Survivorship - the proportion of newborn individuals that are alive at a given age. (Draft Recovery Plan)

Take - Under the Endangered Species Act, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect an animal, or to attempt to engage in any such conduct. (Draft Recovery Plan)

Taking (Section 7) - implementing an action that results in take. (Draft Recovery Plan)

Talus - broken rock forming a more or less continuous layer that may or may not be covered by duff and litter. (Scientific Analysis Team)

Taxon - a category in scientific classification system, such as class, family, or phylum. (Draft Recovery Plan)

Territorial single - an unpaired owl that is defending a territory. (Draft Recovery Plan)

Territory - the area that an animal defends, usually during breeding season, against intruders of its own species. (Draft Recovery Plan)

Texture of an ecosystem - relative surface smoothness of an ecosystem as determined by remote sensing technology, or the distinctiveness of the transition between two distinct ecosystems. (ISC Report)

Threatened species - those plant or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future as identified by the Secretary of Interior as threatened, in accordance with the 1973 Endangered Species Act. (Draft Recovery Plan)

Threshold phenomenon - pattern or trend in population growth rate that exhibits relatively long periods of slow change followed by precipitous increase or decrease in response to an environmental gradient. (ISC Report)

Threatened species - those plant or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future as is defined in the Endangered Species Act. (Draft Recovery Plan)

Timber production - the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use other than for fuelwood. (Draft Recovery Plan)

Timber stand improvement - measures such as thinning, pruning, release cutting, prescribed fire, girdling, weeding, or poisoning of unwanted trees aimed at improving growing conditions for the remaining trees. (Draft Recovery Plan)

Transition period - a period of environmental change during which a population increases or decreases to a new stable equilibrium level. (Scientific Analysis Team)

Understory - the trees and other woody species growing under a more or less continuous cover of branches and foliage formed collectively by the upper portions of adjacent trees and other woody growth. (Draft Recovery Plan)

Uneven-aged management - the application of a combination of actions needed to simultaneously maintain continuous tall forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection. (Draft Recovery Plan)

Unsupervised Classification - a computer-automated technique of pattern recognition which attempts to find statistically similar groups of reflectance values in satellite image data. (Scientific Analysis Team)

USDA - U.S. Department of Agriculture. (Draft Recovery Plan)

USDI - U.S. Department of Interior. (Draft Recovery Plan)

Vagility - capacity of any organism to become widely dispersed. (ISC Report)

Viability - the ability of a population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a specific population for a specified period. (Draft Recovery Plan)

Viable population - a population which has adequate numbers and dispersion of reproductive individuals to ensure the continued existence of the species population on the planning area (FSM 1905). (FEIS)

Vital rates - the rates of key demographic functions within a population, such as the birth rate and survival rate. (Draft Recovery Plan)

Watershed - the forested area contributing water and sediments to a stream or lake. (Scientific Analysis Team)

Watershed analysis - procedure used to identify ecologically important areas of a watershed that create and maintain fish habitat. (Scientific Analysis Team)

Watershed protection areas - portions of a watershed that contribute to the creation and maintenance of fish habitat. (Scientific Analysis Team)

Well distributed - a geographic distribution of habitats that maintains a population throughout a planning area and allows for interaction of individuals through periodic interbreeding and colonization of unoccupied habitats. (Draft Recovery Plan)

West-side forests - the 11 National Forests with the range of the northern spotted owl in Washington, Oregon, and California that lie west of the Cascade Mountain Range crest. They are the Gifford Pinchot, Mendocino, Mt. Baker-Snoqualmie, Mt. Hood, Olympic, Rogue River, Siskiyou, Siuslaw, Six Rivers, Umpqua, and Willamette National Forests. (Draft Recovery Plan)

Wetlands - areas that are inundated by surface water or groundwater with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction (Executive Order 11990). (Draft Recovery Plan)

[Wetlands - areas inundated by surface water or groundwater frequently enough to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soils for growth and reproduction. (Late-Successional Forests Report)]

Wild and scenic rivers - those rivers or sections of rivers designated as such by congressional action under the 1968 Wild and Scenic Rivers Act, as supplemented and amended, or those sections of rivers designated as wild, scenic, or recreational by an act of the legislature of the state or states through which they flow. Wild and scenic rivers may be classified and administered under one or more of the following categories:

- 1) Wild River Areas - those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
2. Scenic River Areas - those rivers or sections of rivers that are free of impoundments with watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
3. Recreational River Areas - those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past. (Draft Recovery Plan)

Wilderness - areas designated by congressional action under the 1964 Wilderness Act. Wilderness is defined as undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation. Wilderness areas are protected and managed to preserve their natural conditions, which generally appear to have been affected primarily by the forces of nature, with the imprint of human activity substantially unnoticeable; have outstanding opportunities for solitude or for a primitive and confined type of recreation; include at least 5,000 acres or are of sufficient size to make practical their preservation, enjoyment, and use in an

unimpaired condition; and may contain features of scientific, education, scenic, or historical value as well as ecologic and geologic interest. (Draft Recovery Plan)

Wildfire - any wildland fire that is not a prescribed fire. (Draft Recovery Plan)

Windfall - trees or parts of trees felled by high winds. See also blowdown and windthrow. (Draft Recovery Plan)

Windthrow - a tree or group of trees uprooted by the wind. (Draft Recovery Plan)

Young stands - forest stands not yet mature (generally, less than 50-80 years old; typically 20-40 years old). (Late-Successional Forests Report)

THE OFFICE ON ENVIRONMENTAL POLICY

Old Executive Office Building

Suite 360

Washington, DC 20501

(202) 456-6224

NAME	EXT.	ISSUE AREA
Dan Blank	x6543	Internat'l Trade & Development
Clare Breidenich	~~x6543~~	Intern (Blank & Doniger)
Marc Chupka	x6551	Economics/Energy
Ken Connolly	x6548	Presidential Mgmt Intern
David Cottingham	x6549	Natural Resources
Harriet Crosby	x6224	Volunteer
David Doniger	395-6938	Global Environment
Keith Laughlin	x6541	Pollution Prevention (incl. Superfund, WTI, RCRA)
Murray Liebman	x6457	Volunteer (Research Asst for John Shafer)
Trey Lindseth	x6531	Special Asst/Correspondence; Special Projects
Christian Marsh	x6533	Special Asst/Scheduling; Exec Asst. to Katie
Pam McElwee	x6542	Spec. Asst/Congr. & Public Affairs
Katie McGinty	X6224	
John Shafer	x6550	Sustainable Development
Brian Rydell	x6224	Volunteer
Cathy Zoi	x6530	Chief of Staff
Kurt Zwally	x6224	Special Asst./Special Projects; Exec. Asst to Katie & Cathy

Note: these are not public numbers.