Will Management of Vulnerable Species Protect Biodiversity?

Selection of management indicator species has been used to ensure that the biodiversity of forest ecosystems is protected. Such species could be selected by their degree of imperilment. A coarse-scale review investigates whether this system finds species that are strongly associated with old-growth ponderosa pine ecosystems in Idaho, Montana, and Washington. Inland vertebrates were selected based on global or national imperilment rankings and endangered species candidate lists. Their ranges were coarsely mapped and habitat associations determined. Among the findings: vulnerability criteria designate primarily fish species that are not associated with upland ponderosa pine forests, and fail to target any terrestrial vertebrate species strongly associated with this declining community.

By Leonard E. Broberg

Conservation of ecosystems and the biodiversity within them is often considered a desirable goal of forest management. Several recent reviews of western US ecosystems have identified substantial declines in old-growth ponderosa pine *(Pinus ponderosa)* ecosystems. The interior Columbia Basin scientific assessment found a 60 percent decline in single-layer old-forest structures, predominantly in ponderosa pine forest types (Quigley et al. 1996). Noss et al. (1995) reviewed the literature and estimated an 85 percent reduction of old-growth ponderosa pine ecosystems from historical conditions.

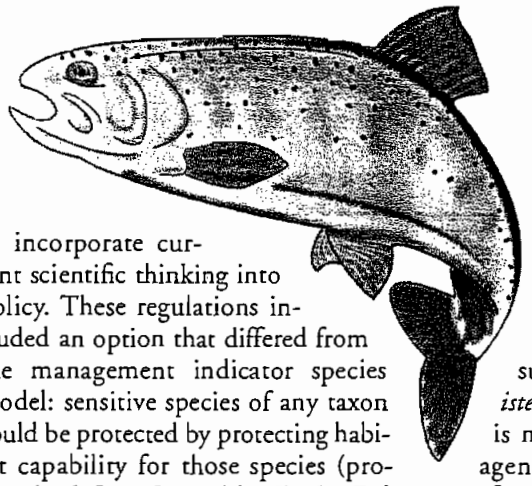
The National Forest Management Act (NFMA)(16 U.S.C. §§ 1600 *et seq.*) establishes the basic legal requirement for biodiversity protection in national forests: to "provide for diversity of plant and animal communities" (16 U.S.C. § 1604(g)(3)(B)) and maintain the viability of these ecosystems on National Forest System lands. Traditionally, viability of ecosystems has been judged by monitoring the status of individual species dependent on them. Proposed Forest Service regulations would adopt species imperilment classifications as the standard for designating species (other than those listed as threatened or endangered under the Endangered Species Act) whose habitat needs will direct national forest management. This paper makes a coarse-scale review of the effects of this imperilment-based conservation strategy on old-growth ponderosa pine ecosystem monitoring and protection in Idaho, Montana, and Washington.

Protecting biodiversity requires the integration of science, policy, and law. Ecologists have proposed many systems for prioritizing species and communities needing protection (e.g., Walker 1995; Scott et al. 1993). Policy implementations of biodiversity protection, however, have lagged behind these scientific developments. The regulations promulgated pursuant to NFMA's legal requirement for protecting biodiversity include maintaining viable populations of vertebrate species in the forest, and selecting and designating management indicator species to represent the communities in the forest (36 CFR § 219.9). Under current law and regulations, therefore, management for indicator species is intended to protect the communities on which they depend. Several selection criteria are designated (36 CFR § 219.9):

1. Endangered and threatened plants and animals.
2. Species with special habitat needs.
3. Hunted, fished, or trapped species.
4. Nongame species of special interest.
5. Indicator species.

Both the concept of management indicator species and its implementation have been criticized on legal (Alverson et al. 1994) and biological grounds (Landres et al. 1988; Alverson et al. 1994) for being susceptible to political concerns. An alternative would be to use concrete standards based on biological criteria.

In 1995 the Forest Service proposed new regulations to meet the diversity mandate of NFMA (60 *Federal Register* 18886-18932). Thus an opportunity arose to modify the current regulations



Of the fish species designated as sensitive, none are so strongly associated with old-growth ponderosa pine forests that protection of the aquatic species would protect the declining ecosystem. Upland forests in particular would not be helped by management strategies designed to conserve the fish.

to incorporate current scientific thinking into policy. These regulations included an option that differed from the management indicator species model: sensitive species of any taxon could be protected by protecting habitat capability for those species (proposed 36 CFR §219.4(b)(5); 60 *Federal Register* 18922). Sensitive species replace the management indicator species under this option. Instead of following a set of broad criteria for selecting indicators, the new regulations would adopt the vulnerability rankings of the Natural Heritage Network (see Master 1991) and the United States Fish and Wildlife Service category 1 and 2 candidate species lists under the Endangered Species Act.

The Natural Heritage Network rankings *(table 1)* are based on the number of occurrences, observed and reported, of a taxon and an estimate of the threat of its extinction at global (G) and national (N) scales or as a subspecies (T). Rankings proceed from the most critically imperiled (rank 1) to the most widespread, abundant, and secure (rank 5).

Category 1 candidates are species for which the US Fish and Wildlife Service "has on file sufficient information on biological vulnerability and threat(s) to support proposal to list them as endangered or a threatened species. Proposed rules have not yet been issued because this action is precluded at present by other listing activity" (59 *Federal Register* 59883).

Category 2 candidates are species for which the US Fish and Wildlife Service has information indicating that listing as endangered or threatened *may* be appropriate, but "persuasive data on biological vulnerability and threat" are insufficient to support listing (59 *Federal Register* 59883). The category 2 list is no longer maintained by the agency, and its membership is now fixed as of November 15, 1994, when the last list was published (59 *Federal Register* 58992).

Species would be classified as sensitive if they fell inro any of the following categories:

1. All G1 and G2 species.
2. All T1 and T2 subspecies.
3. All caregory 1 candidate species.
4. All category 2 candidate species also holding ranks G3, N3, or T3 or higher (proposed 36 CFR § 219.4(b)(5)(i)(A)-(C); 60 *Federal Register* 18922; see Master 1991).

Thus, the regulatory scheme selects species to guide management by their relative imperilment. The regulations offer concrete biological criteria based on listing status, abundance, geographic range, trends in population or range, threats, sensitivity to human disturbance, and other considerations. At the same time the focus of forest planning is to restore and maintain the "sustainability" of rare natural communities ranked G1–G3, N1–N3, or S1–S2 (proposed 36 CFR § 219.4(b)(3); 60 *Federal Register* 18922). Compliance with the Endangered Species Act and the proposed regulations (proposed 36 CFR § 219.4(b)(4); 60 *Federal Register* 18922) also require that management recognize the needs of listed threatened and endangered species. Management for vulnerable natural communities or wilderness could play a role in protecting ecosystems under the new standards. However, the sensitive species and threatened and endangered species requirements of the proposed regulations will define the extent of biodiversity protection through species habitat needs.

Table 1. Natural Heritage Network ranking criteria for globally (G) and nationally (N) imperiled species and subspecies (T).

G1, N1, T1	Critically imperiled because of extreme rarity (five or fewer occurrences, or very few remaining individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G2, N2, T2	Imperiled because of rarity (six to 20 occurrences), or because other factors demonstrably make it very vulnerable to extinction throughout its range.
G3, N3, T3	Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; 21 to 100 occurrences.
G4, N4, T4	Apparently secure, though it may seem quite rare in parts of its range, especially at the periphery.
G5, N5, T5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

SOURCE: Master (1991).

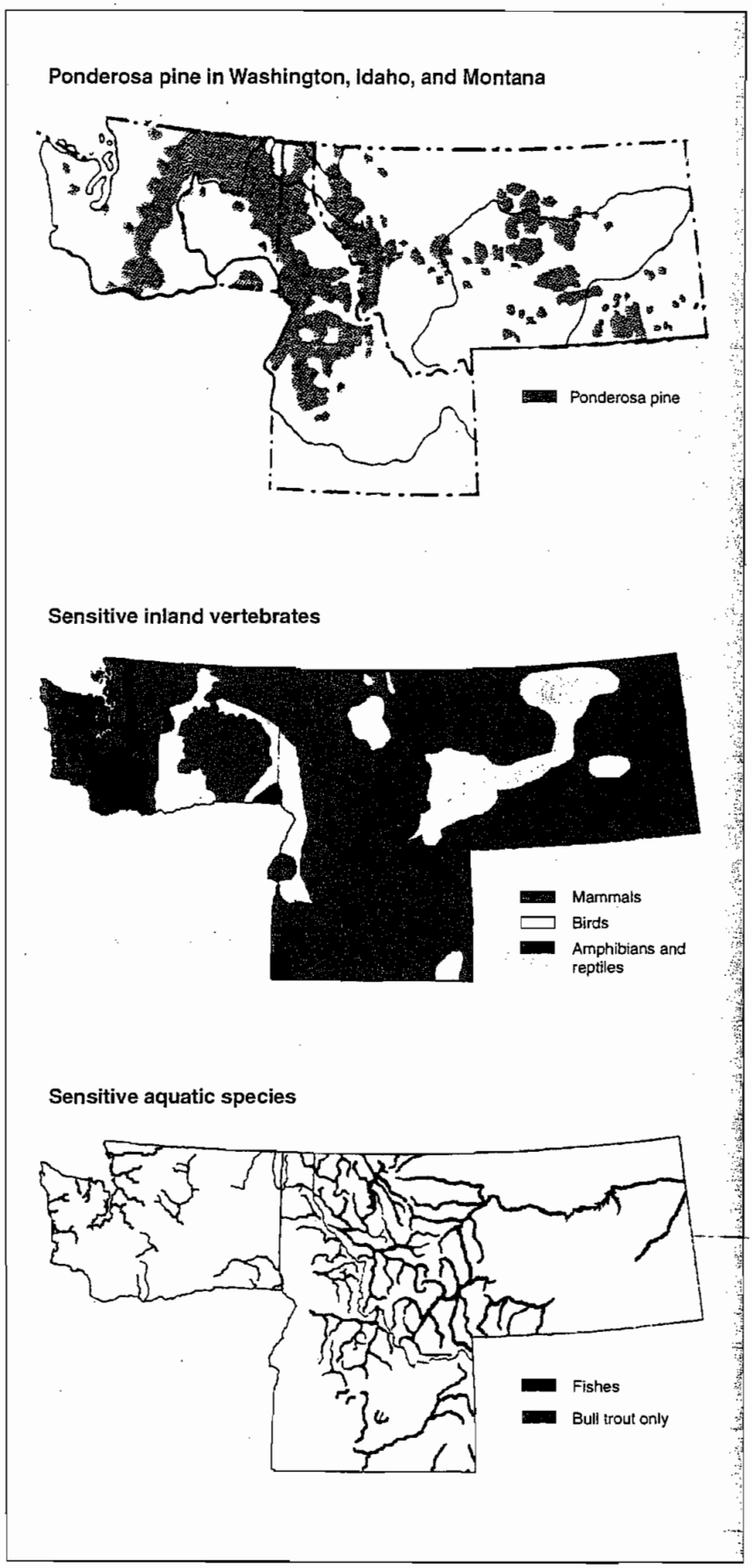


***Figure 1. Top: Pinus ponderosa* range in Washington, Idaho, and Montana, from Barrett et al. (1980). *Middle:* Ranges of sensitive inland mammals, birds, amphibians, and reptiles. White areas indicate the absence of any sensitive species associated with forests for that area. Ranges are from Washington Gap Analysis project maps, Hall (1981) or Koehler and Aubry (1994). *Bottom:* Major rivers and streams bearing sensitive aquatic species. Bull trout range overlaps sensitive species range through much of the three-state area between the Cascades and the Continental Divide. Ranges from USDA and USDI (1997) and Lee (1980).**

Threatened and endangered species have an established management framework that has been extensively analyzed elsewhere. They can provide protection to old-growth ecosystems where they are found (e.g., the northern spotted owl). The presence of sensitive species associated with an ecosystem or community and the degree of overlap between those species' habitat requirements and the requirements for a functional natural system are important determinants of ecosystem and community protection under this conservation scheme. As a result, sensitive species, which are designated by definite criteria, would play an important role in biodiversity protection on National Forest System lands, especially where threatened and endangered species are not present.

Methodology

The protection of ponderosa pine communities and ecosystems through inland vertebrate sensitive species designation was evaluated at coarse scale in Idaho, Montana, and Washington. Past national forest management has emphasized vertebrates more than plants and invertebrates (see the viable population requirement of 36 CFR 219.19), and vertebrates will continue to play an important, if not dominant, role in ecosystem protection through species management. Inland vertebrate species (nonmarine species associated with freshwater and noncoastal habitats) designated by the applicable rank-

ings or listings were determined through national and state lists from the Nature Conservancy and the International Network of Natural Heritage Programs and Conservation Data Centers and US Fish and Wildlife Service category 1 and category 2 candidate lists. Lists of inland vertebrates ranked N3 or higher for the three states were obtained from the Nature Conservancy Natural Heritage Central Databases (Nature Conservancy 1999). The national ranking search excluded exotics and accidentals. When species were designated with a mixed ranking (i.e., G3–G4), they were reviewed based on the highest rank.

Species ranges and community-ecosystem or physiographic associations of sensitive species were also determined from literature review. The ranges were coarsely mapped based on range descriptions and existing analog or digital maps. Species richness of proposed sensitive species was not shown; maps were based on the presence of at least one proposed sensitive species in an area. Partial ranges are mapped to simplify the figure where multiple coverages exist. Gaps in coverage were assessed based on the map and information from the literature about the association of designated species with ponderosa pine. Mapping was based on historical rather than current information in many cases, so the resulting distribution areas are in some cases larger or smaller than represented and definitely more patchy. Resolution of the maps was nonetheless adequate for the coarse-scale analysis, which assumed that if the range maps showed a presence and the literature supported an association with old-growth ponderosa pine, that range within the ecosystem was protected.

Results

Based on the sensitive species vulnerability criteria, ponderosa pine ecosystems east of the Cascade range are protected primarily by various fishes: few imperiled terrestrial species are associated with forests *(table 2, p. 17)*. East of the Cascades the species ranges show that Canadian lynx and Columbia spotted frogs are the only terrestrial vertebrates meeting sensitive species criteria that could be present *(table 2, fig. 1)*. Canadian lynx habitat preferences do not generally include low-elevation ponderosa pine forests. Instead, lynx prefer higher-elevation lodgepole and spruce-fir forest types (Koehler 1990). The Columbia spotted frog, although found in old-growth ponderosa pine forests, occupies habitats ranging from Douglas-fir forests to sagebrush (Blaustein et al. 1995) and would be designated as a sensitive species only in Idaho south of the Snake River (G. Stephens, pers. commun.).

Likewise, although numerous fish species would be designated as sensitive, none of them have a definite association with old-growth ponderosa pine forests. Many of the listed aquatic vertebrates range across a number of forest types, and management for these species could be considered adequate overall, even though the old-growth ponderosa pine ecosystem may be declining. In addition, management for aquatic species has focused more on the riparian zone than on upland areas. The Inland Native Fish Strategy (USDA-FS 1995), for example, limited management within 150 feet or one tree height of fish-bearing streams. It allowed some type of harvest up to 20 feet from the stream. If management for aquatic species follows this trend, upland old-growth ponderosa pine ecosystems would not be covered by sensitive species designated through use of the conservation scheme proposed for national forests east of the Cascades. The use of vulnerability criteria for vertebrate sensitive species results in (1) management for subspecies of limited distribution, (2) management for grassland species, (3) management for few interior forest species east of the Cascades, particularly at low elevations, (4) protection of aquatic systems, and (5) failure to target a terrestrial vertebrate species strongly associated with at least one broad type of declining community.

The pattern of vertebrate species designation holds at the state level as well. A review of Washington's vulnerable species *(table 2)*, for instance, shows that many of the taxa are grassland species (streaked horned lark, pocket gophers, and ground squirrels) and western forest species (salamanders, Townsend's big-eared bat, California wolverine, and Pacific fisher subspecies). In addition, the ranges of the terrestrial vertebrates are concentrated in the Cascades and to the west *(fig. 1)*, whereas ponderosa pine ecosystems are generally east of the Cascades. The vulnerable species in Idaho are primarily grassland species and aquatic species whose ranges cover a large portion of the state, but protection of nonaquatic systems in the north depends on the Canadian lynx. Protection of ecosystems in Montana, likewise, depends on grassland species and aquatic species; the only vulnerable species listed for upland forests in the western portion of the state is the Canadian lynx.

Certain species identified through the search were excluded from the species lists because they were transient or reported extinct within the three-state area: mountain plover *(Charadrius montanus)* in Washington and Idaho (Jewett et al. 1953), Yosemite toad *(Bufo canorus)* in Montana (Stebbins 1985), and woodland caribou *(Rangifer tarandus caribou)* in Montana (Scott and Servheen 1985).

A number of species were included despite their marginal ranks (i.e., G3–G4, N3–N4, or T3–T4): the California bighorn sheep, Townsend's western big-eared bat subspecies, spotted bat, Pacific fisher, and Olympic torrent salamander in Washington. Inclusion of these species is not certain under the proposed designation criteria. Their inclusion could overstate the coverage given to ponderosa pine ecosystems by sensitive species designations under these criteria.

Discussion

Use of species designated based on the imperilment criteria set forth in the proposed forest planning regulations of the Forest Service to guide management may be inadequate to protect upland old-growth ponderosa pine ecosystems in the Idaho, Montana, and Washington. This shortcoming results from four factors:

1. There are gaps where designated species are not found in the ecosystem.

2. Some designated species' ranges overlap the distribution of the ecosystem, but the species' habitat does not include the ecosystem.

3. Some designated species' ranges overlap the distribution of the ecosystem, but the species has no strong association with the ecosystem.

4. Protection aimed at aquatic species may not reach upland forests.

The conservation scheme may need to be reconsidered to prevent further decline of the upland old-growth ponderosa pine ecosystem through sensitive species management. Aquatic species like the westslope cutthroat trout *(fig. 1)* could provide substantial protection, depending on the reach of management standards. Westslope cutthroat trout are sensitive to sedimentation (Weaver and Fraley 1993). A whole-watershed approach to management could offer some protection to old-growth ponderosa pine stands but would require revision of current standards applicable to aquatic species conservation.

Management for threatened and endangered species would protect the bull trout, several salmon and steelhead stocks (i.e., fall and spring runs of Snake River chinook), and northern spotted owl in old-growth ponderosa pine ecosystems in this three-state area. The range of the northern spotted owl, however, extends only to the eastern slope of the Cascades in Washington. Bull trout could provide significant protection to this ecosystem in Idaho and Montana where they occur in old-growth ponderosa pine ecosystems. Management of upland areas is important in perpetuating the conditions required by bull trout. One recent scientific review of bull trout requirements (Sanborn et al. 1998) found that the entire watershed in core bull trout habitat needs to be managed to prevent increases in sediment delivery. This could focus concern on upland old-growth ecosystems in core bull trout habitat.

Protection of all species or subspecies ranked 3 or higher on the global or national scales has been suggested elsewhere (Noss and Cooperrider 1994). Adopting a rank-3 threshold, however, may not facilitate ecosystem-level protection: species with much stronger associations with the old-growth ponderosa pine ecosystem, such as northern goshawk *(Accipiter gentilis)* and the flammulated owl *(Otus flammelous),* are ranked G4 or G5.

Imperilment criteria alone do not ensure that species sufficiently connected to an ecosystem or community of interest will be designated and the elements, form, structure, or function of that ecosystem will therefore be protected. It would be inappropriate to use vulnerability rankings as the sole criteria for selecting species to guide management if the goal is to protect ecosystems or communities from detrimental declines in quality or extent. Imperilment remains a legitimate basis for selecting species to manage for their own sake, however.

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Noss and Peters (1995) show that 10 to 24 listed C1 or C2 species are found in ancient ponderosa pine ecosystems throughout the United States. There are several possible reasons their list does not coincide with the species designated by the criteria examined here. First, some C2 species (e.g., the northern goshawk) are not ranked high enough to make this list. Second, ponderosa pine is a widely distributed species, and some of the species included in this count could range outside the three-state area. Third, several species listed under the Endangered Species Act are found in these ecosystems (listed steelhead and salmon runs and the northern spotted owl are not included in the sensitive species list, and at least the northern spotted owl in Washington can be said to depend on the form and structure found in old-growth ponderosa pine forests). Fourth, their list included all species, including plants and invertebrates, not just inland vertebrates. These species could play an important role in protecting these ecosystems.

Given the past management focus on vertebrates, the investment in staff for vertebrate management within the Forest Service, and the differing habitat needs of vertebrates, however, management of forest ecosystems should include a strong vertebrate component to enhance management of declining ecosystems. Including all category 2 vertebrate species and "watch species," or "species of concern" would broaden the species monitored in upland old-growth ponderosa pine ecosystems. It would add vertebrates like the flammulated owl, northern goshawk, and pygmy nuthatch *(Sitta pygmaea)* that are more strongly associated with the ecosystem.

Despite the deficiencies of the management indicator species concept, with revision it could remain a workable part of protecting biodiversity on national forest lands. A stronger alternative to the sensitive species proposal and the current indicators species concept could include the management for all species or subspecies listed G3, N3, T3, or higher; all C1 and C2; watch species (or species of concern); and selected species whose viability, based on the literature and other scientific information, depends on important elements of ecosystem function, structure, and composition. This will require the redefinition of the management indicator species language to require designating some species that depend on the ecosystem. Only by making an analysis of species, conditions, and factors relevant to preserving declining ecosystems within each national forest and then setting concrete standards for protecting the species dependent on those ecosystems can we preserve and restore biodiversity on the national forests.

Table 2. Inland vertebrate sensitive species designated by vulnerability according to various ranking systems: global (G), national (N), subspecies (T), category (C).

Mammals			
*Townsend's western big-eared bat	*Corynorhinus townsendii towndsendii*	N3, N4, T3, T4, C2	Washington
Spotted bat	*Euderma maculatum*	N3, N4, C2	Washington, Idaho, Montana
*California wolverine	*Gulo gulo luteus*	N3, T2, T3, C2	Washington
*Canadian lynx	*Lynx canadensis*	C1	Washington, Idaho, Montana
*Pacific fisher	*Martes pennanti pacifica*	G3, G4, N3, N4, C2	Washington
Kincaid meadow vole	*Microtus pennsylvanicus kincaidi*	T3, C2	Washington
Shaw Island vole	*Microtus townsendii pugeti*	N1, N2, C2	Washington
*Pacific fringe-tailed bat	*Myotis thysanodes vespertinum*	T2, C2	Washington
California bighorn sheep	*Ovis canadensis californiana*	N3, N4, C2	Washington, Idaho
Destruction Island shrew	*Sorex trowbridgii*	N1, C2	Washington
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	N2, C1	Idaho
Southern Idaho ground squirrel	*Spermophilus brunneus endemicus*	N2, C2	Idaho
Washington ground squirrel	*Spermophilus washingtoni*	G2	Washington
Northern pocket gopher	*Thomomys talpoides douglasii*	T1, C1	Washington
Western pocket gopher	*Thomomys mazama couchi*	N1, T1, C2	Washington
	Thomomys mazama glacialis	N1, T1, C2	Washington
	Thomomys mazama louiei	N1, T1, C2	Washington
Swift fox	*Vulpes velox*	G3, C2	Montana
Birds			
Baird's sparrow	*Ammodramus bairdii*	N3, C2	Montana
Western sage grouse	*Centocercus urophasianus phaios*	N3, C2	Washington
Mountain plover	*Charadrius montanus*	N2, C2	Montana
Streaked horned lark	*Eremophila alpestris strigata*	T2	Washington
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	N3, T2, T3, C2	Washington, Idaho, Montana
Amphibians			
*Larch Mountain salamander	*Plethodon larselli*	G2, C2	Washington
*Oregon spotted frog	*Rana pretiosa*	T2, C1	Washington
*Columbia spotted frog	*Rana lutieventris* Great Basin population	C1	Idaho
*Cascade torrent salamander	*Rhycotriton cascadae*	G2, G3	Washington
*Columbia torrent salamander	*Rhyacotriton kezeri*	G2, G3	Washington
*Olympic torrent salamander	*Rhyacotriton olympicus*	G2, G3	Washington
Reptiles			
Northwestern pond turtle	*Clemmys marmorata marmorata*	G3, T3, N3, C2	Washington
Fish			
Shoshone sculpin	*Cottus greenei*	G2, C2	Idaho
Wood River sculpin	*Cottus leiopomonus*	G2, C2	Idaho
Margined sculpin	*Cottus marginatus*	G3, C2	Washington
Leatherside chub	*Gila copei*	N3, N4, C2	Idaho
Sturgeon chub	*Macrhybopsis gelida*	N2	Montana
Sicklefin chub	*Macrhybopsis meeki*	N3, C1	Montana
Olympic mudminnow	*Novumbra hubbsi*	G3, C2	Washington
Yellowstone cutthroat trout	*Oncorhyncus clarki bouvieri*	T2	Idaho, Montana
Westslope cutthroat trout	*Oncorhyncus clarki lewisi*	T3, C2	Idaho, Montana
Bonneville cutthroat trout	*Oncorhyncus clarki utah*	T2, C2	Idaho
Bear Lake cutthroat trout	*Oncorhyncus clarki* population 3	T1	Idaho
Snake River fine-spotted cutthroat trout	*Oncorhyncus clarki* ssp2	T1, T2	Idaho
Bear Lake whitefish	*Prosopium abyssicola*	G1	Idaho
Bonneville cisco	*Prosopium gemmifer*	G1	Idaho
Bonneville whitefish	*Prosopium spilonotus*	G1	Idaho
Spotted whitefish	*Prosopium* (species uncertain)	G1	Idaho
Pallid sturgeon	*Scaphirhynchus albus*	N1, N2	Montana
Arctic grayling (Upper Missouri River fluvial population)	*Thymallus arcticus*	N2, C1	Montana

NOTE: Global and national ranks were obtained through searches of the state Natural Heritage Programs and Conservation Data Centers and the national Natural Heritage Database (Nature Conservancy 1999).

**Species associated with forests.*

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