APPENDIX 2-1—KEY ECOLOGICAL FUNCTIONS OF SPECIES

A Hierarchical Classification of KEFs and KECs

I Classification of the Key Ecological Functions (KEFs) of Wildlife

(Marcot and Vander Heyden 2001)

1. Trophic relationships
    - 1.1. heterotrophic consumer (an organism that is unable to manufacture its own food and must feed on other organisms)
        - 1.1.1. primary consumer (herbivore; an organism that feeds primarily on plant material) (also see below under Herbivory)
            - 1.1.1.1. foliovore (leaf eater)
            - 1.1.1.2. spermivore (seed eater)
            - 1.1.1.3. browser (leaf, stem eater)
            - 1.1.1.4. grazer (grass, forb eater)
            - 1.1.1.5. frugivore (fruit eater)
            - 1.1.1.6. sap feeder
            - 1.1.1.7. root feeders
            - 1.1.1.8. nectivore (nectar feeder)
            - 1.1.1.9. fungivore (fungus feeder)
            - 1.1.1.10. flower/bud/catkin feeder
            - 1.1.1.11. aquatic herbivore
            - 1.1.1.12. feeds in water on decomposing benthic substrate (benthic is the lowermost zone of a water body)
            - 1.1.1.13. bark/cambium/bole feeder
        - 1.1.2 secondary consumer (primary predator or primary carnivore; a carnivore that preys on other vertebrate or invertebrate animals, primarily herbivores)
            - 1.1.2.1 invertebrate eater
                - 1.1.2.1.1 terrestrial invertebrates
                - 1.1.2.1.2 aquatic macroinvertebrates (e.g., not plankton)
                - 1.1.2.1.3 freshwater or marine zooplankton
            - 1.1.2.2 vertebrate eater (consumer or predator of herbivorous or carnivorous vertebrates)
                - 1.1.2.2.1 piscivorous (fish eater)

1.1.2.3 ovivorous (egg eater)

1.1.3 tertiary consumer (secondary predator or secondary carnivore; a carnivore that preys on other carnivores)

1.1.4 carrion feeder (feeds on dead animals)

1.1.5 cannibalistic (eats members of its own species)

1.1.6 coprophagous (feeds on fecal material)

1.1.7 feeds on human garbage/refuse

1.1.7.1 aquatic (e.g., offal and bycatch of fishing boats)

1.1.7.2 terrestrial (e.g., garbage cans, landfills)

1.2 prey relationship

1.2.1 prey for secondary or tertiary consumer (primary or secondary predator)

2. Aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)

3. Organismal relationships

3.1. controls or depresses insect population peaks

3.2. controls terrestrial vertebrate populations (through predation or displacement)

3.3. pollination vector

3.4. transportation of viable seeds, spores, plants, or animals (through ingestion, caching, caught in hair or mud on feet, etc.)

3.4.1. disperses fungi

3.4.2. disperses lichens

3.4.3. disperses bryophytes, including mosses

3.4.4. disperses insects and other invertebrates (phoresis)

3.4.5. disperses seeds/fruits (through ingestion or caching)

3.4.6. disperses vascular plants

3.5. creates feeding, roosting, denning, or nesting opportunities for other organisms

3.5.1. creates feeding opportunities (other than direct prey relations)

3.5.1.1.creates sapwells in trees

3.5.2. creates roosting, denning, or nesting opportunities

3.6. primary creation of structures (possibly used by other organisms)

3.6.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)

3.6.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)

3.6.3. aquatic structures (muskrat lodges, beaver dams)

- 3.7. user of structures created by other species
  - 3.7.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)
  - 3.7.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)
  - 3.7.3. aquatic structures (muskrat lodges, beaver dams)
- 3.8. nest parasite
  - 3.8.1. interspecies parasite (commonly lays eggs in nests of other species)
  - 3.8.2. common interspecific host (parasitized by other species)
- 3.9. primary cavity excavator in snags or live trees (organisms able to excavate their own cavities)
- 3.10. secondary cavity user (organisms that do not excavate their own cavities and depend on primary cavity excavators or natural cavities)
- 3.11. primary burrow excavator (fossorial or underground burrows)
  - 3.11.1. creates large burrows (rabbit-sized or larger)
  - 3.11.2. creates small burrows (less than rabbit-sized)
- 3.12. uses burrows dug by other species (secondary burrow user)
- 3.13. creates runways (possibly used by other species; runways typically are worn paths in dense vegetation)
- 3.14. uses runways created by other species
- 3.15. pirates food from other species
- 3.16. interspecific hybridization (species known to regularly interbreed)

4. Carrier, transmitter, or reservoir of vertebrate diseases
   - 4.1. diseases that affect humans
   - 4.2. diseases that affect domestic animals
   - 4.3. diseases that affect other wildlife species
5. Soil relationships
   - 5.1. physically affects (improves) soil structure, aeration (typically by digging)
   - 5.2. physically affects (degrades) soil structure, aeration (typically by trampling)
6. Wood structure relationships (either living or dead wood)
   - 6.1. physically fragments down wood
   - 6.2. physically fragments standing wood
7. Water relationships
   - 7.1. impounds water by creating diversions or dams

  7.2. creates ponds or wetlands through wallowing

8. Vegetation structure and composition relationships
   - 8.1. creates standing dead trees (snags)
   - 8.2. herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
   - 8.3. herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)

II Defining Habitat Elements—Key Environmental Correlates (KECs)

(O'Neil *et al.* 2001)

Site-specific habitat elements are those components of the environment believed to most influence wildlife species distribution, abundance, fitness, and viability (definition adapted from Marcot *et al*. (1997) and Mayer and Laudenslayer (1988). In this context, habitat elements include natural attributes, both biological and physical (e.g., large trees, woody debris, cliffs, and soil characteristics) as well as anthropogenic features and their effects such as roads, buildings, and pollution. Including these fine-scale attributes of an animal's environment when describing the habitat associations for a particular species expands the concept and definition of habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species. Failing to assess and inventory habitat elements within these communities and conditions may lead to errors of commission; species may be presumed to occur when in actuality they do not. Habitat elements that influence a species negatively may preclude occupancy or breeding despite adequate floristic or structural conditions.

Traditionally defined, the term habitat is that set of environmental conditions, usually depicted as food, water, and cover, used and selected for by a given organism.

Despite this broad definition, many land management agencies use the term habitat to denote merely the vegetation conditions and/or structural or seral stages used by a particular species. However, many other environmental attributes or features influence and affect the population viability of wildlife species. Marcot *et al*. (1997) in their assessment of the terrestrial species of the Columbia River Basin emphasized the importance of examining all features that exert influence on wildlife by expanding the definition of habitat to encompass all environmental correlates, naming the entirety of these attributes key environmental correlates or KECs. All environmental scales, from broad floristic communities to fine-scale within-stand features, were included in their definition of a KEC. The word "key" in key environmental correlate refers to the high degree of influence (either positive or negative) the environmental correlates exert on the realized fitness of a given species. Nonetheless, when this information was determined, only direct relationships between the habitat element and a species were identified. Most of the habitat elements-species associations refer to mostly positive influences between the habitat elements and the species. Negative influence between habitat elements and the species may be viewed as environmental stressors; however, a comprehensive list of negative influences is not presented here.

The list of habitat elements and their definitions was derived from Marcot *et al*.1997 and was refined and edited based on the published literature and expert review. The final list comprises 287 habitat elements, including naturally occurring biological and physical elements as well as elements created or caused by human actions. Definitions are provided to characterize each element and clarify the nature of its influence on wildlife species. The following are habitat elements definitions.

1. Forest, shrubland, and grassland habitat elements

Biotic, naturally occurring attributes of forest and shrubland communities; the information that follows is for mostly positive relationships.

1.1 Forest/woodland vegetative elements or substrates. Biotic components found within a forested context.

1.1.1 Down wood. Includes downed logs, branches, and rootwads.

1.1.1.1 Decay class. A system by which down wood is classified based on its deterioration.

1.1.1.1.1 hard (class 1, 2). Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas 1979.

1.1.1.1.2 moderate (class 3). Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas 1979.

1.1.1.1.3 soft (class 4, 5). Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas 1979.

1.1.1.2 Down wood in riparian areas. Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to instream woody debris.

1.1.1.3 Down wood in upland areas. Includes downed wood in upland areas of forest habitats.

1.1.2 Litter. The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.

1.1.3 Duff. The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.

1.1.4 Shrub layer. Refers to the shrub strata within forest stands.

Biotic components found within a shrubland or grassland context (these are positive influences only).

1.2.1 Herbaceous layer. Zone of understory nonwoody vegetation beneath shrub layer (nonforest context). May include forbs, grasses.

1.2.2 Fruits/seeds/nuts. Plant reproductive bodies that are used by animals.

1.2.3 Moss. Large group of green plants without flowers but with small leafy stems growing in clumps.

1.2.4 Cactus. Any of a large group of drought resistant plants with fleshy, usually jointed stems and leaves replaced by scales or spines.

1.2.5 Flowers. A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.2.6 Shrubs. Plant with persistent woody stems and <16.5 feet tall; usually produces several basal shoots as opposed to a single bole.

1.2.6.1 Shrub size. Refers to shrub height.

1.2.6.1.1 small <2.0 feet

1.2.6.1.2 medium 2.0–6.5 feet

1.2.6.1.3 large 6.5–16.5 feet

1.2.6.2 Percent shrub canopy cover. Percent of ground covered by vertical projection of shrub crown diameter.

1.2.6.3 Shrub canopy layer. Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.

1.2.6.3.1 Subcanopy. The space below the predominant shrub crowns.

1.2.6.3.2 Above canopy. The space above the predominant shrub crowns.

1.2.7 Fungi. Mushrooms, molds, yeasts, rusts, etc.

1.2.8 Forbs. Broad-leaved herbaceous plants. Does not include grasses, sedges, or rushes.

1.2.9 Bulbs/tubers. Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.2.10 Grasses. Members of the Graminae family.

1.2.11 Cryptogamic crusts. Nonvascular plants that grow on the soil surface. Primarily lichens, mosses, and algae. Often found in arid or semiarid regions. May form soil surface pinnacles.

1.2.12 Trees (located in a shrubland/grassland context). Small groups of trees or isolated individuals.

1.2.12.1 Snags. Standing dead trees.

1.2.12.1.1 Decay class. System by which snags are classified based on their deterioration.

1.2.12.1.1.1 hard. Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown 1985.

1.2.12.1.1.2 moderate. Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown 1985.

1.2.12.1.1.3 soft. Well-decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown 1985.

1.2.12.2 Snag size. Measured in dbh, as previously defined.

1.2.12.2.1 shrub/seedling <1 inch dbh

1.2.12.2.2 sapling/pole 1–9 inches dbh

1.2.12.2.3 small tree 10–14 inches dbh

1.2.12.2.4 medium tree 15–19 inches dbh

1.2.12.2.5 large tree 20–29 inches dbh

1.2.12.2.6 giant tree >30 inches dbh

1.2.12.3 Tree size. Measured in dbh, as previously defined.

1.2.12.3.1 shrub/seedling <1 inch dbh

1.2.12.3.2 sapling/pole 1–9 inches dbh

1.2.12.3.3 small tree 10–14 inches dbh

1.2.12.3.4 medium tree 15–19 inches dbh

1.2.12.3.5 large tree 20–29 inches dbh

1.2.12.3.6 giant tree >30 inches dbh

1.2.13 Edges. The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

2. Ecological habitat elements

Selected interspecies relationships within the biotic community; they include both positive and negative influences.

2.1 Exotic species. Any nonnative plant or animal, including cats, dogs, and cattle.

2.1.1 Plants. This field refers to the relationship between an exotic plant species and animal species.

2.1.2 Animals. This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 Predation. The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 Direct displacement. The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 Habitat structure change. The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 Other. Any other effects of an exotic species on a native species.

2.2 Insect population irruptions. The species directly benefits from insect population irruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 Mountain pine beetle. The species directly benefits from mountain pine beetle eruptions.

2.2.2 Spruce budworm. The species directly benefits from spruce budworm irruptions.

2.2.3 Gypsy moth. The species directly benefits from gypsy moth irruptions.

2.3 Beaver/muskrat activity. The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.

2.4 Burrows. Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3. Nonvegetative, Abiotic, Terrestrial Habitat Elements

Nonliving components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

3.1 Rocks. Solid mineral deposits.

3.1.1 Gravel. Particle size from 0.1–3.0 inches (0.2–7.6 cm) in diameter; gravel bars associated with streams and rivers are a separate category.

3.1.2 Talus. Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.

3.1.3 Talus-like habitats. Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.

3.2 Soils. Various soil characteristics.

3.2.1 Soil depth. The distance from the top layer of the soil to the bedrock or hardpan below.

3.2.2 Soil temperature. Any measure of soil temperature or range of temperatures that are key to the queried species.

3.2.3 Soil moisture. The amount of water contained within the soil.

3.2.4 Soil organic matter. The accumulation of decomposing plant and animal materials found within the soil.

3.2.5 Soil texture. Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay, etc.

3.3 Rock substrates. Various rock formations.

3.3.1 Avalanche chute. An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder, *Alnus sinuate*, and/or vine maple, *Acer circinatum*).

3.3.2 Cliffs. A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.

3.3.3 Caves. An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.

3.3.4 Rocky outcrops and ridges. Areas of exposed rock.

3.3.5 Rock crevices. Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 Barren ground. Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 Playa (alkaline, saline). Shallow desert basins that are without natural drainage ways where water accumulates and evaporates seasonally.

3.4 Snow. Selected features of snow.

3.4.1 Snow depth. Any measure of the distance between the top layer of snow and the ground below.

3.4.2 Glaciers, snow field. Areas of permanent snow and ice.

4. Freshwater Riparian and Aquatic Bodies Habitat Elements

Includes selected forms and characteristics of any body of freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.

4.1.1 Dissolved oxygen. Amount of oxygen passed into solution.

4.1.2 Water depth. Distance from the surface of the water to the bottom substrate.

4.1.3 Dissolved solids. A measure of dissolved minerals in water

4.1.4 Water pH. A measure of water acidity or alkalinity.

4.1.5 Water temperature. Water temperature range that is key to the queried species; if known, it is in the comments field.

4.1.6 Water velocity. Speed or momentum of water flow.

4.1.7 Water turbidity. Amount of roiled sediment within the water.

4.1.8 Free water. Water derived from any source.

4.1.9 Salinity and alkalinity. The presence of salts.

4.2 Rivers and streams. Various characteristics of streams and rivers.

4.2.1 Oxbows. A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 Order and class. Systems of stream classification.

4.2.2.1 Intermittent. Streams/rivers that contain nontidal flowing water for only part of the year; water may remain in isolated pools.

4.2.2.2 Upper perennial. Streams/rivers with a high gradient, fast water velocity, no tidal influence; some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand; little floodplain development.

4.2.2.3 Lower perennial. Streams/rivers with a low gradient, slow water velocity, no tidal influence; some water flowing throughout the year, substrate consists mainly of sand and mud; floodplain is well developed.

4.2.3 Zone. System of water body classification based on the horizontal strata of the water column.

4.2.3.1 Open water. Open water areas not closely associated with the shoreline or bottom.

4.2.3.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within 3.2 feet (1 m) of the substrate.

4.2.3.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.2.4 In-stream substrate. The bottom materials in a body of water.

4.2.4.1 Rocks. Rocks >10 inches (256 mm) in diameter.

4.2.4.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type >70% cover.

4.2.4.3 Sand/mud. Fine substrata <.01 inch (1mm) in diameter, little gravel present, may be mixed with organics.

4.2.5 Vegetation. Herbaceous plants.

4.2.5.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.2.5.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.2.5.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.2.6 Coarse woody debris in streams and rivers. Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.

4.2.7 Pools. Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.

4.2.8 Riffles. Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

4.2.9 Runs/glides. Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

4.2.10 Overhanging vegetation. Herbaceous plants that cascade over stream and river banks and are <3.2 feet (1 m) above the water surface.

4.2.11 Waterfalls. Steep descent of water within a stream or river.

4.2.12 Banks. Rising ground that borders a body of water.

4.2.13 Seeps or springs. A concentrated flow of ground water issuing from openings in the ground.

4.3 Ephemeral pools. Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 Sand bars. Exposed areas of sand or mud substrate.

4.5 Gravel bars. Exposed areas of gravel substrate.

4.6 Lakes/ponds/reservoirs. Various characteristics of lakes, ponds, and reservoirs.

4.6.1 Zone. System of water body classification based on the horizontal strata of the water column.

4.6.1.1 Open water. Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 In-water substrate. The bottom materials in a body of water.

4.6.2.1 Rock. Rocks >10 inches (256 mm) in diameter.

4.6.2.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

4.6.2.3 Sand/mud. Fine substrata <.1 inch (2.5 mm) in diameter, little gravel present, may be mixed with organics.

4.6.3 Vegetation. Herbaceous plants.

4.6.3.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.6.3.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 Size. Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 Ponds. Bodies of water <5 acre (2 ha).

4.6.4.2 Lakes. Bodies of water >5 acre (2 ha).

4.7 Wetlands/marshes/wet meadows/bogs and swamps. Various components and characteristics related to any of these systems.

4.7.1 Riverine wetlands. Wetlands found in association with rivers.

4.7.2 Context When checked, indicates that the setting of the wetland, marsh, wet meadow, bog, or swamp is key to the queried species.

4.7.2.1 Forest. Wetlands within a forest.

4.7.2.2 Nonforest. Wetlands that are not surrounded by forest.

4.7.3 Size. When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog, or swamp based on the size of the water body.

4.7.4 Marshes. Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.

4.7.5 Wet meadows. Grasslands with waterlogged soil near the surface but without standing water for most of the year.

4.8 Islands. A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.

4.9 Seasonal flooding. Flooding that occurs periodically due to precipitation patterns.

5. Marine Habitat Elements

Selected biotic and abiotic components and characteristics of marine systems - water depth, and relationship to substrate.

5.1.1 Supratidal. The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).

5.1.2 Intertidal. The zone between the higher high water line and the lower low water line.

5.1.3 Nearshore subtidal. The zone that extends from the lower low water line seaward to the 65 foot (20 m) isobath, typically within 0.6 miles (1 km) of shore.

5.1.4 Shelf. The area between the 65–650 feet (20–200 m) isobath, typically within 36 miles (60 km) of shore.

5.1.5 Oceanic. The zone that extends seaward from the 650 feet (200 m) isobath.

5.2 Substrates. The bottom materials of a body of water.

- 5.2.1 Bedrock. The solid rock underlying surface materials.
- 5.2.2 Boulders. Large, worn, rocks >10 inches (256 mm) in diameter.
- 5.2.3 Hardpan. Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface that sloughs frequently.
- 5.2.4 Cobble. Rocks or pebbles, 2.5–10 inches (64–256 mm) in diameter, may be a mix of cobbles, gravel, shells, and sand, with no type exceeding 70% cover.
- 5.2.5 Mixed-coarse. Substrata consisting of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.
- 5.2.6 Gravel. Small rocks or pebbles, 0.2–2.5 inches (4–64 mm) in diameter.
- 5.2.7 Sand. Fine substrata <0.2 inch (4 mm) in diameter, little gravel present, may be mixed with organics.
- 5.2.8 Mixed-fine. Mixture of sand and mud particles <0.2 inch (4 mm) in diameter, little gravel present.
- 5.2.9 Mud. Fine substrata <0.002 inch (0.06 mm) in diameter, little gravel present, usually mixed with organics.
- 5.2.10 Organic. Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.

5.3 Energy. Degree of exposure to oceanic swell, currents, and wind waves.

- 5.3.1 Protected. No sea swells, little or no current, and restricted wind fetch.
- 5.3.2 Semi-protected. Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate-to-weak tidal currents.
- 5.3.3 Partially exposed. Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong-to-moderate tidal currents.
- 5.3.4 Exposed. Highly exposed to oceanic swell, wind waves, and/or very strong currents.

5.4 Vegetation. Includes herbaceous plants and plants lacking vascular systems.

- 5.4.1 Mixed macro algae. Includes brown, green, and red algae.
- 5.4.2 Kelp. Subaquatic rooted vegetation found in the nearshore marine environment
- 5.4.3 Eelgrass. Subaquatic rooted vegetation found in an estuarine environment

5.5 Water depth. Refers to the vertical layering of the water column.

- 5.5.1 Surface layer. The uppermost part of the water column.
  - 5.5.1.1 Tide rip. A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.
  - 5.5.1.2 Surface microlayer (neuston). The thin uppermost layer of the water surface.

5.5.2 Euphotic. Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.

5.5.3 Disphotic. Area below the euphotic zone where photosynthesis ceases.

5.5.4 Demersal/benthic. Submerged lands including vegetated and unvegetated areas.

5.6 Water temperature. Measure of ocean water temperature.

5.7 Salinity. The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field.

5.8 Forms. Morphological elements within marine areas.

5.8.1 Beach. An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.

5.8.2 A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.

5.8.3 Marine cliffs (mainland). A sloping face steeper than 20½ usually formed by erosion and composed of either bedrock and/or unconsolidated materials.

5.8.4 Delta. An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.

5.8.5 Dune. In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).

5.8.6 Lagoon. Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.

5.8.7 Salt marsh. A coastal wetland area that is periodically inundated by tidal brackish or salt water and that supports significant (15% cover) nonwoody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.

5.8.8 Reef. A rock outcrop, detached from the shore, with maximum elevations below the high-water line.

5.8.9 Tidal flat. A level or gently sloping (<5½) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.

5.9 Water clarity. As influenced by sediment load.

6. (No Data)

Formerly contained topographic information, such as elevation, that has been moved to the life history matrix.

7. Fire as a Habitat Element

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

8. Anthropogenic Related Habitat Elements

This section contains selected examples of human-related habitat elements that may be a key part of the environment for many species. These habitat elements may have either a negative or positive influence on the queried species.

- 8.1 Campgrounds/picnic areas. Sites developed and maintained for camping and picnicking.
- 8.2 Roads. Either paved or unpaved.
- 8.3 Buildings. Permanent structures.
- 8.4 Bridges. Permanent structures typically over water or ravines.
- 8.5 Diseases transmitted by domestic animals. Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.
- 8.6 Animal harvest or persecution. Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.
- 8.7 Fences/corrals. Wood, barbed wire, or electric fences.
- 8.8 Supplemental food. Food deliberately provided for wildlife (e.g., bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.
- 8.9 Refuse. Any source of human-derived garbage (includes landfills).
- 8.10 Supplemental boxes, structures and platforms. Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.
- 8.11 Guzzlers and waterholes. Water sources typically built for domestic animal use.
- 8.12 Toxic chemical use. Proper use of regulated chemicals; documented effects only.
  - 8.12.1 Herbicides/fungicides. Chemicals used to kill vegetation and fungi.
  - 8.12.2 Insecticides. Chemicals used to kill insects.
  - 8.12.3 Pesticides. Chemicals used to kill vertebrate species.
  - 8.12.4 Fertilizers. Chemicals used to enhance vegetative growth.
- 8.13 Hedgerows/windbreaks. Woody and/or shrubby vegetation either planted or that develops naturally along fence lines and field borders.
- 8.14 Sewage treatment ponds. Settling ponds associated with sewage treatment plants.
- 8.15 Repellents. Various methods used to repel or deter wildlife species that damage crops or property (excluding pesticides and insecticides).
  - 8.15.1 Chemical (taste, smell, or tactile). Chemical substances that repel wildlife.

8.15.2 Noise or visual disturbance. Nonchemical methods to deter wildlife.

8.16 Culverts. Drain crossings under roads or railroads.

8.17 Irrigation ditches/canals. Ditches built to transport water to agricultural crops or to handle runoff.

8.18 Powerlines/corridors. Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.

8.19 Pollution. Human-caused environmental contamination.

8.19.1 Chemical. Contamination caused by chemicals.

8.19.2 Sewage. Contamination caused by human waste.

8.19.3 Water. Aquatic contamination from any source.

8.20 Piers. Structures built out over water.

8.21 Mooring piles, dolphins, buoys. Floating objects anchored out in the water for nautical purposes.

8.22 Bulkheads, seawalls, revetment. Retaining structures built to protect the shoreline from wave action.

8.23 Jetties, groins, breakwaters. Structures built to influence the current or protect harbors.

8.24 Water diversion structures. Structures built to funnel or direct water, including dams, dikes and levies.

8.25 Log boom. A raft of logs lashed together either to transport the logs or as barriers to boat traffic near marinas or dams.

8.26 Boats/ships. Watercraft, either motorized or nonmotorized.

8.27 Dredge spoil islands. Sediment deposited from dredging operations.

8.28 Hatchery facilities and fish. Fish that are hatched in captivity and later released into the wild. For simplicity this refers to freshwater areas, though marine birds and mammals likely feed on hatchery released fish too. This also includes the facilities and their operation.

III Major Assumptions with the IBIS Data set

The Northwest Habitat Institute (NHI) Interactive Biodiversity Information System (IBIS), supplied the data set used in the assessment of the key ecological functions for the wildlife species in the subbasins. The data set included information from basinwide wildlife habitat maps. Vegetation maps from all or parts of seven states (Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming) in the Columbia River Basin were used by NHI to develop the wildlife habitat maps depicting current conditions. These maps were developed to serve as an initial basis for large-scale mapping or database investigations.

Consequently, the wildlife habitat maps used in this assessment provide only an initial depiction of the amounts of wildlife habitats that may exist within watersheds, but are not of sufficient resolution for depicting the site-specific location of habitats within each watershed. Thus, wildlife habitats that occur in patch sizes less than 250 acres (i.e., linear riparian habitat) are likely underrepresented in the assessment.

Further, there has been no formal validation of the basinwide current wildlife habitat maps. Because maps are only a representation of reality and cannot depict all the detail represented in nature, some generalization is unavoidable. It is also important to not that remotely sensed maps developed from photograph interpretation or satellite imagery also contain errors.

NHI also developed a historic map by combining products from two previous works: Interior Columbia Basin Ecosystem Management Project (ICBEMP 1997) and the Oregon Biodiversity Project (Defenders of Wildlife 1998). These two mapping efforts used very different methods. The ICBEMP historic data were mostly derived from a modeling exercise, and the Oregon Biodiversity Project map was created from using surveyor notes from the 1850 land survey. Thus, the historic map is a theoretical construct with a coarse (1-km^2 pixel size) level of resolution. Wildlife habitats that are small or linear in size or shape (i.e., riparian or herbaceous wetlands) are underrepresented in the historic condition maps. In addition, no validation of the historic map was completed, and because there are no recognized historical data sets presently available, validation is difficult. Hence, the historic map best depicts gross generalizations of gains or loses of specific wildlife habitats.

B Total Functional Richness

Total functional richness is an ecological functional pattern that totals the number of KEF categories in a community. Total functional richness denotes the degree of functional complexity in a community, such that the more functionally diverse communities have a greater measure of total functional richness. The total functional richness in a community also denotes the degree to which the full “functional web” of a community would be provided or conserved (Marcot and Vander Heyden, 2001).

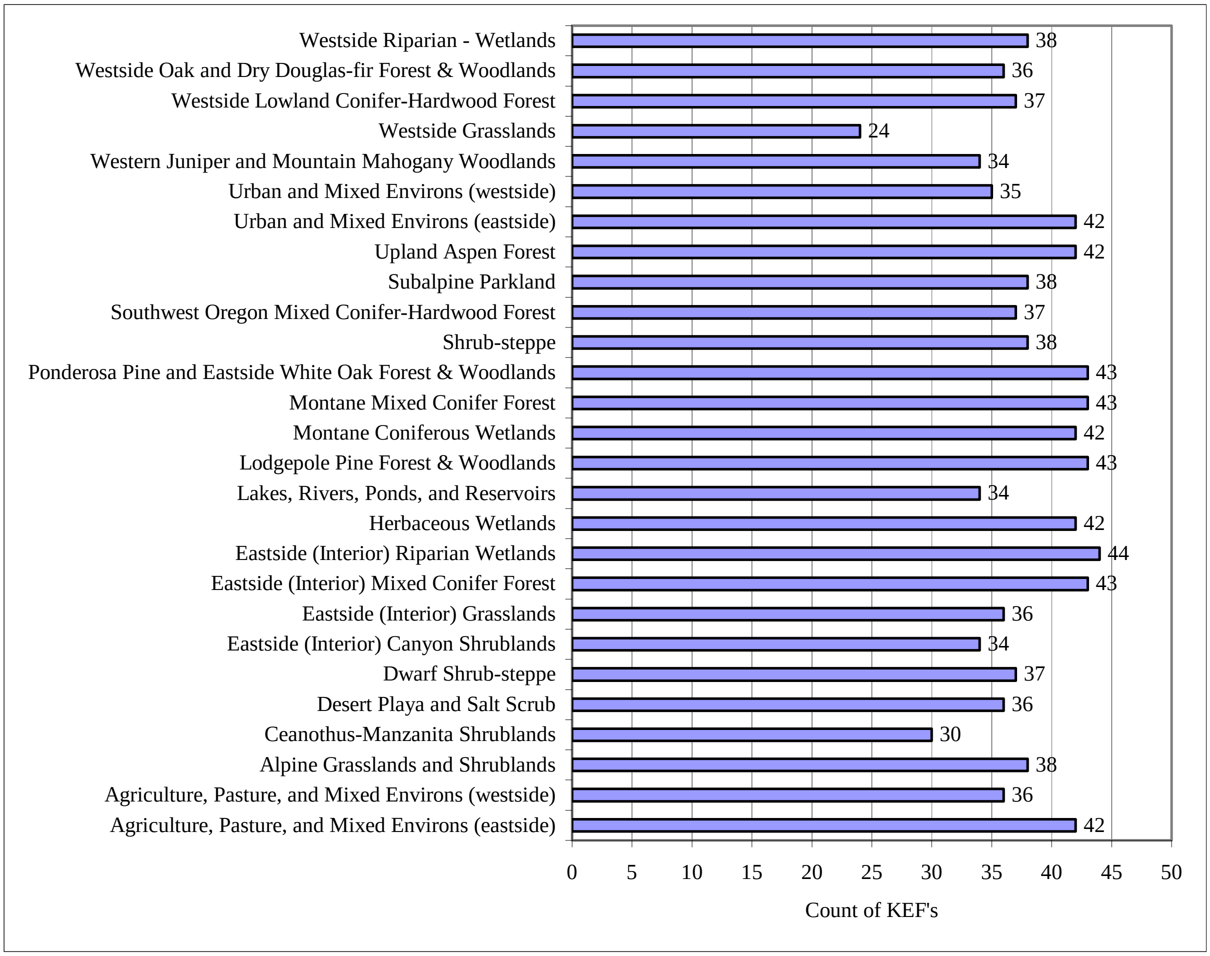

Figure 1. Total functional richness (number of KEFs) by wildlife habitat in the Boise, Payette, and Weiser subbasins (source: IBIS 2003).

C Wildlife Species Associated with Aquatic Environments

Table 1. Wildlife species identified as having associations with aquatic habitats in the Boise, Payette, and Weiser subbasins. This table was generated by searching the IBIS data set for species with category 4 KECs and then summing their respective KEFs and KECs.

Wildlife Species	KEF	KEC	Total Count
American avocet	14	24	38
American badger	12	4	16
American beaver	23	29	52
American bittern	11	9	20
American coot	23	23	46
American crow	18	6	24

Wildlife Species	KEF	KEC	Total Count
American dipper	9	27	36
American marten	14	5	19
American robin	12	1	13
American white pelican	10	16	26
American wigeon	19	23	42
Bald eagle	12	21	33
Bank swallow	11	12	23
Barn owl	9	3	12
Barn swallow	9	3	12
Barred owl	13	10	23
Barrow's goldeneye	12	17	29
Belted kingfisher	15	22	37
Big brown bat	10	14	24
Black bear	30	5	35
Black swift	5	3	8
Black tern	20	7	27
Black-billed magpie	17	4	21
Black-capped chickadee	15	4	19
Black-crowned night-heron	17	16	33
Black-necked stilt	14	20	34
Blue grouse	14	7	21
Blue-winged teal	17	18	35
Bobcat	7	3	10
Bobolink	9	3	12
Bufflehead	14	21	35
Bullfrog	14	19	33
Burrowing owl	12	4	16
California gull	16	16	32
California myotis	8	14	22
California quail	14	3	17
Canada goose	14	18	32
Canvasback	17	35	52
Caspian tern	15	19	34
Cattle egret	16	4	20
Chukar	14	3	17
Cinnamon teal	18	18	36
Clark's grebe	14	16	30
Cliff swallow	9	7	16
Columbia spotted frog	12	21	33
Common garter snake	12	11	23

Wildlife Species	KEF	KEC	Total Count
Common goldeneye	12	21	33
Common loon	11	12	23
Common merganser	15	21	36
Common nighthawk	5	3	8
Common raven	17	3	20
Common tern	14	8	22
Common yellowthroat	10	8	18
Cooper’s hawk	9	4	13
Coyote	15	3	18
Double-crested cormorant	13	15	28
Dunlin	8	27	35
Eared grebe	13	17	30
Eastern kingbird	14	4	18
Feral horse	13	8	21
Fisher	17	3	20
Forster’s tern	17	19	36
Franklin’s gull	17	9	26
Fringed myotis	8	10	18
Gadwall	19	19	38
Golden eagle	11	2	13
Gray partridge	14	3	17
Gray wolf	15	11	26
Great Basin spadefoot	15	18	33
Great blue heron	18	19	37
Great egret	17	21	38
Great gray owl	8	5	13
Great horned owl	9	4	13
Greater yellowlegs	10	31	41
Green heron	10	12	22
Green-winged teal	18	20	38
Harlequin duck	6	40	46
Heather vole	12	2	14
Hoary bat	8	12	20
Hooded merganser	15	20	35
Horned grebe	13	17	30
Idaho giant salamander	12	17	29
Killdeer	13	29	42
Lesser scaup	16	28	44
Lincoln’s sparrow	15	3	18
Little brown myotis	8	13	21

Wildlife Species	KEF	KEC	Total Count
Long-billed curlew	15	19	34
Long-eared myotis	7	14	21
Long-legged myotis	8	14	22
Long-tailed vole	10	3	13
Long-toed salamander	15	30	45
Mallard	20	23	43
Marsh wren	8	13	21
Meadow vole	17	5	22
Merlin	6	6	12
Mink	17	12	29
Montane shrew	8	4	12
Montane vole	13	3	16
Moose	11	29	40
Mountain chickadee	15	4	19
Mountain goat	7	3	10
Mountain lion	9	3	12
Mountain quail	14	3	17
Mourning dove	9	8	17
Mule deer	18	7	25
Muskrat	17	23	40
Northern goshawk	9	5	14
Northern harrier	8	6	14
Northern leopard frog	13	21	34
Northern pintail	18	20	38
Northern pocket gopher	13	5	18
Northern river otter	12	45	57
Northern rough-winged swallow	9	12	21
Northern saw-whet owl	8	4	12
Northern shoveler	16	14	30
Northern shrike	8	4	12
Northern waterthrush	7	3	10
Olive-sided flycatcher	8	2	10
Osprey	8	15	23
Pacific chorus (tree) frog	14	18	32
Pacific-slope flycatcher	13	5	18
Pallid bat	8	13	21
Peregrine falcon	5	6	11
Pied-billed grebe	10	15	25
Preble’s shrew	7	4	11
Pronghorn antelope	13	6	19

Wildlife Species	KEF	KEC	Total Count
Raccoon	21	12	33
Red-breasted merganser	14	7	21
Red-eyed vireo	12	4	16
Redhead	19	31	50
Red-necked grebe	13	16	29
Red-tailed hawk	12	4	16
Red-winged blackbird	12	8	20
Ring-billed gull	18	16	34
Ring-necked duck	17	36	53
Ring-necked pheasant	16	7	23
Rocky Mountain bighorn sheep	8	3	11
Rocky Mountain elk	20	8	28
Rough-legged hawk	7	2	9
Rubber boa	8	4	12
Ruddy duck	14	29	43
Ruffed grouse	16	7	23
Sandhill crane	22	20	42
Savannah sparrow	13	2	15
Sharp-shinned hawk	9	4	13
Sharp-tailed grouse	17	3	20
Short-eared owl	8	5	13
Silver-haired bat	10	9	19
Snow goose	18	18	36
Snowy egret	16	15	31
Solitary sandpiper	9	21	30
Sora	16	13	29
Spotted bat	7	12	19
Spotted sandpiper	14	34	48
Spruce grouse	12	6	18
Striped skunk	16	9	25
Swainson’s hawk	9	2	11
Tailed frog	11	12	23
Tiger salamander	15	18	33
Townsend’s big-eared bat	10	14	24
Tree swallow	11	6	17
Trumpeter swan	16	23	39
Tundra swan	13	19	32
Turkey vulture	3	3	6
Upland sandpiper	11	5	16
Vagrant shrew	12	3	15

Wildlife Species	KEF	KEC	Total Count
Violet-green swallow	10	8	18
Virginia rail	14	14	28
Water shrew	10	23	33
Water vole	12	11	23
Western grebe	16	16	32
Western harvest mouse	16	8	24
Western jumping mouse	9	2	11
Western pipistrelle	7	11	18
Western sandpiper	8	27	35
Western screech-owl	8	4	12
Western small-footed myotis	8	12	20
Western terrestrial garter snake	14	7	21
Western toad	15	27	42
White-faced ibis	15	10	25
White-tailed deer	14	11	25
White-tailed kite	10	3	13
Wild turkey	17	3	20
Willet	15	20	35
Wilson’s phalarope	16	22	38
Wilson’s snipe	12	19	31
Wolverine	5	6	11
Wood duck	16	21	37
Woodhouse’s toad	13	19	32
Yellow warbler	11	3	14
Yellow-billed cuckoo	11	10	21
Yellow-breasted chat	10	3	13
Yellow-headed blackbird	9	8	17
Yellow-pine chipmunk	18	4	22
Yuma myotis	8	13	21

D Critical Functional Link Species

Critical functional link species are those species that perform unique KEFs in a community. In other words, for a particular habitat or community, the critical functional link species are species that perform certain ecological functions that no other species perform.

Not all of the roles performed by critical functional link species are critical, however, such that communities would not collapse if some of these species were absent. For example, the brown-headed cowbird is identified as a critical functional link species for many habitats in the Boise, Payette, and Weiser subbasins because it is the only species that acts as a nest parasite (Table 2). Even though there would be impacts to communities if the brown-headed cowbird were to disappear from all the habitats it frequents, it is unlikely that the communities would collapse due to its absence. The disappearance of the brown-headed cowbird would most likely benefit communities because the reproductive success of other bird species would improve.

On the other hand, the rufous hummingbird and black-chinned hummingbird are vertebrate species that act as a pollination vectors for several habitats. If these hummingbirds were to disappear and there were no other pollinators for the plants in the communities they inhabited, then the effect could greatly alter the community habitat structure and function. In this scenario, the hummingbird species might be considered functional keystone species, such that their removal altered the structure and function of a community.

Table 2. List of species that perform critical functional roles in the Boise, Payette, and Weiser subbasins, Idaho (source: IBIS 2003).

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
Agriculture, pasture, and mixed environs (eastside)	1.1.5	cannibalistic	Great Basin spadefoot
	1.1.6	coprophagous (feeds on fecal material)	Nuttall's (mountain) cottontail
	3.3	pollination vector	Black-chinned hummingbird
	3.5.1	creates feeding opportunities (other than direct prey relations)	Great blue heron
	3.5.2	creates roosting, denning, or nesting opportunities	Great blue heron
	3.6.1	aerial structures	Great blue heron
	3.6.2	ground structures	American bittern
	3.7.2	ground structures	Western fence lizard
	3.7.3	aquatic structures	Tundra swan
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Downy woodpecker
	6.2	physically fragments standing wood	Lewis's woodpecker
	7.1	impounds water by creating diversions or dams	American beaver
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
	7.2	creates ponds or wetlands through wallowing	Feral horse
Alpine grasslands and shrublands	1.1.5	cannibalistic	Black bear
	1.1.6	coprophagous (feeds on fecal material)	Snowshoe hare
	3.3	pollination vector	Bullock's oriole

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
	3.7.1	aerial structures	Great horned owl
	3.7.2	ground structures	Deer mouse
	6.2	physically fragments standing wood	Black bear
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
	8.1	creates standing dead trees (snags)	American beaver
Ceanothus-manzanita shrublands	1.1.5	cannibalistic	Black bear
	3.4.1	disperses fungi	Deer mouse
	3.4.4	disperses insects and other invertebrates	Golden-mantled ground squi
	3.4.6	disperses vascular plants	Golden-mantled ground squi
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	4.3	diseases that affect other wildlife species	Common porcupine
	6.1	physically fragments down wood	Black bear
	6.2	physically fragments standing wood	Black bear
Desert playa and salt scrub	1.1.5	cannibalistic	Black bear
	3.3	pollination vector	Black-chinned hummingbird
	3.7.1	aerial structures	Great horned owl
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.2	creates ponds or wetlands through wallowing	Feral horse
Dwarf shrub-steppe	3.3	pollination vector	Black-chinned hummingbird
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	6.2	physically fragments standing wood	Black bear
	8.1	creates standing dead trees (snags)	Black bear
Eastside (interior) canyon shrublands	1.1.5	cannibalistic	Great Basin spadefoot
	3.4.4	disperses insects and other invertebrates	Killdeer
	3.4.6	disperses vascular plants	Killdeer
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.7.2	ground structures	Western fence lizard

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	6.2	physically fragments standing wood	Black bear
	7.2	creates ponds or wetlands through wallowing	Feral horse
Eastside (interior) grasslands	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	8.1	creates standing dead trees (snags)	Common porcupine
Eastside (interior) mixed conifer forest	3.5.2	creates roosting, denning, or nesting opportunities	Red squirrel
	3.6.3	aquatic structures	American beaver
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.1	impounds water by creating diversions or dams	American beaver
Eastside (interior) riparian wetlands	3.5.2	creates roosting, denning, or nesting opportunities	Red squirrel
	3.6.2	ground structures	American pika
	4.2	diseases that affect domestic animals	Double-crested cormorant
	7.1	impounds water by creating diversions or dams	American beaver
Herbaceous wetlands	3.5.2	creates roosting, denning, or nesting opportunities	Great blue heron
	3.9	primary cavity excavator in snags or live trees	Williamson’s sapsucker
	4.2	diseases that affect domestic animals	Double-crested cormorant
	6.2	physically fragments standing wood	Lewis’s woodpecker
	7.1	impounds water by creating diversions or dams	American beaver
Lakes, rivers, ponds, and reservoirs	1.1.3	tertiary consumer (secondary predator or secondary carnivore)	Peregrine falcon
	3.5.1	creates feeding opportunities (other than direct prey relations)	Great blue heron
	3.5.2	creates roosting, denning, or nesting opportunities	Great blue heron
	3.7.1	aerial structures	Black tern
	3.8.1	interspecies parasite	Redhead
	4.2	diseases that affect domestic animals	Double-crested cormorant

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
	7.1	impounds water by creating diversions or dams	American beaver
	8.2	herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)	Moose
	8.3	herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	Canada goose
Lodgepole pine forest & woodlands	1.1.6	coprophagous (feeds on fecal material)	Snowshoe hare
	3.4.4	disperses insects and other invertebrates	Common loon
	3.5.2	creates roosting, denning, or nesting opportunities	Great blue heron
	3.6.3	aquatic structures	Pied-billed grebe
	3.7.3	aquatic structures	Tundra swan
	3.8.1	interspecies parasite	Redhead
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
Montane coniferous wetlands	1.1.6	coprophagous (feeds on fecal material)	Snowshoe hare
	3.6.2	ground structures	Bushy-tailed woodrat
	3.6.3	aquatic structures	American beaver
	3.7.2	ground structures	Deer mouse
	3.8.1	interspecies parasite	Brown-headed cowbird
	4.3	diseases that affect other wildlife species	Common porcupine
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
Montane mixed conifer forest	3.5.2	creates roosting, denning, or nesting opportunities	Red squirrel
	3.6.3	aquatic structures	American beaver
	3.7.2	ground structures	Deer mouse
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
Ponderosa pine and eastside white oak forest & woodlands	1.1.6	coprophagous (feeds on fecal material)	American pika
	3.5.2	creates roosting, denning, or nesting opportunities	Red squirrel
	3.6.3	aquatic structures	American beaver

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.1	impounds water by creating diversions or dams	American beaver
Shrub-steppe	3.3	pollination vector	Black-chinned hummingbird
	3.7.3	aquatic structures	Fisher
	3.8.1	interspecies parasite	Brown-headed cowbird
Southwest oregon mixed conifer-hardwood forest	1.1.5	cannibalistic	Great Basin spadefoot
	1.1.6	coprophagous (feeds on fecal material)	Pygmy rabbit
	3.4.2	disperses lichens	Northern flying squirrel
	3.4.4	disperses insects and other invertebrates	Mallard
	3.4.6	disperses vascular plants	Mallard
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.6.1	aerial structures	Osprey
	3.6.2	ground structures	Desert woodrat
	3.6.3	aquatic structures	American beaver
	3.7.1	aerial structures	Great horned owl
	3.7.2	ground structures	Western fence lizard
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Northern flicker
	4.3	diseases that affect other wildlife species	Mallard
	6.1	physically fragments down wood	Northern flicker
	6.2	physically fragments standing wood	Northern flicker
	7.1	impounds water by creating diversions or dams	American beaver
Subalpine parkland	1.1.3	tertiary consumer (secondary predator or secondary carnivore)	Gray wolf
	1.1.5	cannibalistic	Black bear
	3.4.4	disperses insects and other invertebrates	Golden-mantled ground squirrel
	3.4.6	disperses vascular plants	Golden-mantled ground squirrel
	3.6.3	aquatic structures	American beaver
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Fisher
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	6.2	physically fragments standing wood	Black bear
	7.1	impounds water by creating diversions or dams	American beaver

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
Upland aspen forest	1.1.5	cannibalistic	Black bear
	3.4.4	disperses insects and other invertebrates	Golden-mantled ground squirrel
	3.4.6	disperses vascular plants	Golden-mantled ground squirrel
	3.6.2	ground structures	American pika
	3.6.3	aquatic structures	American beaver
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Fisher
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.1	impounds water by creating diversions or dams	American beaver
Urban and mixed environs (eastside)	1.1.5	cannibalistic	Great Basin spadefoot
	1.1.6	coprophagous (feeds on fecal material)	Nuttall's (mountain) cottontail
	3.3	pollination vector	Black-chinned hummingbird
	3.5.1	creates feeding opportunities (other than direct prey relations)	Great blue heron
	3.5.2	creates roosting, denning, or nesting opportunities	Great blue heron
	3.6.1	aerial structures	Great blue heron
	3.6.2	ground structures	Bushy-tailed woodrat
	3.6.2	ground structures	Bushy-tailed woodrat
	3.7.1	aerial structures	Great horned owl
	3.7.2	ground structures	Western fence lizard
	3.7.3	aquatic structures	Mink
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Downy woodpecker
	6.2	physically fragments standing wood	Lewis's woodpecker
	7.1	impounds water by creating diversions or dams	American beaver
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Feral horse
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
Western juniper and mountain	1.1.6	coprophagous (feeds on fecal material)	Nuttall's (mountain) cottontail
	3.3	pollination vector	Bullock's oriole

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
mahogany woodlands	3.4.6	disperses vascular plants	Golden-mantled ground squirrel
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.6.3	aquatic structures	American beaver
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	7.1	impounds water by creating diversions or dams	American beaver
Westside grasslands	1.1.5	cannibalistic	Black bear
	3.4.1	disperses fungi	Deer mouse
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Mink
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	6.1	physically fragments down wood	Feral horse
	6.2	physically fragments standing wood	Black bear
	8.1	creates standing dead trees (snags)	American beaver
Westside lowland conifer-hardwood forest	1.1.5	cannibalistic	Black bear
	1.1.6	coprophagous (feeds on fecal material)	Snowshoe hare
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.6.1	aerial structures	Northern flying squirrel
	3.6.2	ground structures	Bushy-tailed woodrat
	3.6.3	aquatic structures	American beaver
	3.7.1	aerial structures	Northern flying squirrel
	3.7.2	ground structures	Deer mouse
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	4.3	diseases that affect other wildlife species	Common porcupine
	6.2	physically fragments standing wood	Black bear
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
	8.3	herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	Rocky Mountain elk
Westside oak and dry	1.1.5	cannibalistic	Black bear

Habitat	KEF Code	Key Ecological Function	Critical Functional Link Species
douglas-fir forest & woodlands	3.3	pollination vector	Bullock's oriole
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.6.2	ground structures	Bushy-tailed woodrat
	3.6.3	aquatic structures	American beaver
	3.7.1	aerial structures	Northern flying squirrel
	3.7.2	ground structures	Deer mouse
	3.7.3	aquatic structures	Fisher
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	4.3	diseases that affect other wildlife species	Common porcupine
	6.1	physically fragments down wood	Black bear
	6.2	physically fragments standing wood	Black bear
	7.1	impounds water by creating diversions or dams	American beaver
Westside riparian - wetlands	1.1.5	cannibalistic	Black bear
	1.1.6	coprophagous (feeds on fecal material)	Nuttall's (mountain) cottontail
	3.3	pollination vector	Bullock's oriole
	3.5.1	creates feeding opportunities (other than direct prey relations)	Mountain lion
	3.6.1	aerial structures	Eastern gray squirrel
	3.6.2	ground structures	Bushy-tailed woodrat
	3.7.1	aerial structures	Northern flying squirrel
	3.7.2	ground structures	Deer mouse
	3.8.1	interspecies parasite	Brown-headed cowbird
	3.9	primary cavity excavator in snags or live trees	Black bear
	4.3	diseases that affect other wildlife species	Common porcupine
	6.2	physically fragments standing wood	Black bear
	7.1	impounds water by creating diversions or dams	American beaver
	7.2	creates ponds or wetlands through wallowing	Rocky Mountain elk
	8.3	herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	Rocky Mountain elk

E Functional Specialists

Species with the fewest KEFs are functional specialists and may be more vulnerable to extirpation from changes in environmental conditions supporting their ecological functions. There may be several species that perform the same function in a particular habitat, but the functional specialists are species that perform only one or two key ecological functions.

The functional specialist species in the Boise, Payette, and Weiser subbasins are listed in Table 3. There is a total of 57 species.

Table 3. Functional specialist species and their associated KEF count and KEC code in the Boise, Payette, and Weiser subbasins, Idaho (IBIS 2003). KEC codes are provided in section A.

Common Name	Count of KEFs	Habitat Codes	Key Ecological Correlates
American bittern	2	a; n	4.1.2; 4.6.3; 4.7.1; 4.9
American dipper	2	m; n; p	2.3; 3.3.5; 4.1.2; 4.1.6; 4.2.10; 4.2.11; 4.2.12; 4.2.2; 4.2.3; 4.2.4; 4.2.6; 4.2.7; 4.2.8; 4.2.9; 4.6.1; 8.19.3; 8.4
Barn swallow	2	a; c; h; i; k; l; m; n; p; q; s; t; u; v; y; z	1.1.14; 1.2.6; 2.1.2; 3.3.3; 3.3.5; 4.3; 4.4; 8.14; 8.17; 8.18; 8.3; 8.4
Big brown bat	2	a; b; c; e; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; y; z; aa; ab; ac; ad; ae; af	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.1.2; 2.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.1; 8.10; 8.11; 8.12.2; 8.12.3; 8.3; 8.4; 8.6
Black swift	1	c; l; m; n; p; q; s; t; u	1.1.5; 3.3.3; 3.3.5; 4.2.11
Boreal owl	2	l; q; t; y	1.1.14; 1.1.16; 8.10
Brown creeper	2	a; l; m; q; s; t; u; y; z	1.1.14; 1.2.12
California myotis	1	a; b; c; e; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; y; z; aa; ab; ac; ad; ae; af	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.10; 8.11; 8.12.2; 8.12.3; 8.17; 8.3; 8.4
Canyon wren	2	c; i; k; l; m; q; t; u; v	3.1.2; 3.3.2; 3.3.4; 3.3.5
Cliff swallow	2	a; c; h; i; k; l; m; n; p; q; t; u; v; y; z	1.1.14; 1.2.6; 3.3.2; 3.3.4; 4.2.12; 4.3; 4.4; 4.7.1; 8.14; 8.18; 8.3; 8.4
Common nighthawk	1	a; h; i; k; l; m; n; p; q; s; t; u; v; y; z	2.1.1; 3.1.1; 3.1.3; 3.3.4; 3.3.6; 3.3.7; 4.4; 4.5; 7; 8.12.2; 8.2; 8.3
Common poorwill	1	a; h; i; k; l; p; q; u; v	1.2.6; 3.1.1; 3.3.4; 3.3.6; 7; 8.2
Dunlin	2	h; n; p	2.1.1; 2.1.2; 3.2.3; 3.3.6; 3.3.7; 4.1.2; 4.1.6; 4.2.2; 4.2.3; 4.2.4; 4.3; 4.4; 4.5; 4.6.1; 4.6.2; 4.6.3; 4.7.1; 4.8; 4.9; 8.14; 8.18; 8.19.3; 8.20; 8.21; 8.23; 8.25; 8.6
Ferruginous hawk	2	a; h; i; k; v	1.2.10; 1.2.12; 1.2.6; 3.3.2; 3.3.4; 7; 8.18

Common Name	Count of KEFs	Habitat Codes	Key Ecological Correlates
Fringed myotis	2	a; b; j; k; l; m; n; p; s; t; u; v; w; z; aa; ad; ae; af	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.7.1; 8.11; 8.12.2; 8.12.3; 8.19.1; 8.3; 8.4; 8.6
Greater yellowlegs	2	a; h; i; k; m; n; p; v	2.1.1; 3.2.3; 3.3.6; 4.1.6; 4.2.1; 4.2.13; 4.2.2; 4.2.3; 4.2.4; 4.2.5; 4.3; 4.4; 4.5; 4.6.1; 4.6.2; 4.6.3; 4.7.1; 4.7.2; 4.8; 8.14; 8.19.3
Green heron	2	n; p	1.1.14; 2.3; 4.2.1; 4.2.10; 4.2.2; 4.3; 4.6.3; 4.7.1; 8.28
Harlequin duck	1	m; p	1.1.1; 1.1.16; 1.1.4; 4.1.6; 4.2.12; 4.2.2; 4.2.3; 4.2.4; 4.2.6; 4.2.7; 4.2.8; 4.2.9; 4.3; 4.5; 4.6.1; 8.19.1; 8.23; 8.26; 8.6
Hoary bat	1	a; b; e; j; k; l; m; n; p; q; s; t; u; v; w; x; y; z; aa; ab; ac; ad; ae; af	1.1.14; 1.1.16; 1.2.12; 1.2.13; 1.2.6; 2.1.2; 2.3; 4.2.1; 4.2.3; 4.2.7; 4.2.9; 4.6.1; 4.7.1; 8.11; 8.12.2; 8.12.3; 8.13; 8.17; 8.3
Little brown myotis	1	a; b; c; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; y; z; aa; ab; ac; ad; ae; af	1.1.14; 1.2.12; 1.2.13; 2.1.2; 2.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.6.1; 4.7.1; 8.1; 8.10; 8.11; 8.12.2; 8.12.3; 8.13; 8.17; 8.19.1; 8.24; 8.3; 8.4
Loggerhead shrike	2	a; h; i; k; n; v	1.1.16; 1.2.12; 1.2.6; 7; 8.13; 8.18; 8.2; 8.7
Long-eared myotis	1	a; b; c; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; z; aa; ab; ac; ad; ae; af	1.1.1; 1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.1.2; 2.3; 3.1.2; 3.1.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.1; 8.10; 8.11; 8.12.2; 8.12.3; 8.13; 8.17; 8.19.1; 8.3; 8.4
Long-legged myotis	1	a; b; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; z; aa; ab; ac; ad; ae; af	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.3; 3.1.2; 3.1.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.11; 8.12.2; 8.12.3; 8.13; 8.19.1; 8.3; 8.4
Lynx	2	c; l; q; s; t; x	1.1.1; 1.1.14; 1.1.4; 3.4.1; 8.2; 8.6
Marsh wren	2	n	2.1.1; 4.2.2; 4.2.5; 4.6.3; 4.7.1; 8.17
Masked shrew	2	l; m; q; s; t; u; x; ad; af	1.1.1; 1.1.2; 1.1.3; 2.4
Merlin	1	c; i; k; l; m; n; p; q; s; t; u; v	1.1.14; 1.1.16; 1.2.12; 2.1.2; 4.7.1; 4.7.2; 8.12.2; 8.13; 8.3
Northern harrier	2	a; c; h; i; k; m; n; v; z	1.2.1; 1.2.10; 1.2.6; 3.4.1; 4.7.1; 4.7.2; 4.7.3; 7; 8.12.2; 8.6
Northern pygmy-owl	2	a; l; m; n; q; s; t; u; z	1.1.14
Northern saw-whet owl	2	a; l; m; q; s; t; u; y; z	1.1.14; 3.4.1; 4.7.2; 8.10

Common Name	Count of KEFs	Habitat Codes	Key Ecological Correlates
Northern shrike	2	a; h; i; k; n; v	1.2.12; 1.2.13; 1.2.6; 3.4.1; 4.7.2; 7; 8.13; 8.18; 8.7
Northern waterthrush	2	m; af	1.1.13; 1.1.14; 1.1.4; 4.2.12
Olive-sided flycatcher	2	l; m; q; s; t; u	1.1.14; 1.1.16; 7
Osprey	2	a; c; l; m; p; q; t; u; v; z	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.1.2; 2.3; 4.1.7; 4.2.1; 4.2.2; 4.2.3; 4.2.7; 4.6.1; 4.9; 8.10; 8.18; 8.21; 8.28
Pallid bat	1	a; e; h; i; j; k; m; n; p; u; v; w; z; ab; ac; ae; af	1.1.14; 1.1.16; 1.2.1; 1.2.12; 1.2.13; 1.2.6; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 3.3.6; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.1; 8.11; 8.3; 8.4; 8.6
Peregrine falcon	2	h; i; k; l; m; n; p; q; s; t; u; v; y	1.1.14; 1.1.16; 1.2.12; 1.2.13; 2.1.2; 3.3.2; 3.3.4; 3.3.5; 4.7.1; 4.9; 8.10; 8.3; 8.4
Pied-billed grebe	2	m; n; p	4.1.2; 4.2.1; 4.2.3; 4.6.1; 4.6.3; 8.28
Preble’s shrew	2	a; i; k; l; m; n; v; y	4.7.2
Ringneck snake	1	a; u; v; z	1.1.1; 1.1.2; 2.1.1; 2.1.2; 2.4; 3.1.2; 3.1.3; 3.3.4; 3.3.5; 7
Rock wren	2	c; h; i; k; l; u; v	3.1.1; 3.1.2; 3.1.3; 3.3.1; 3.3.2; 3.3.4; 3.3.5
Rough-legged hawk	1	a; c; h; i; k; m; n; u; v; z	1.1.14; 1.2.10; 1.2.12; 3.4.1; 8.13; 8.18; 8.7
Short-eared owl	2	a; h; i; k; n; v	1.2.1; 1.2.10; 1.2.6; 1.2.8; 2.1.1; 2.1.2; 3.4.1; 4.7.2; 4.9; 7; 8.13; 8.6; 8.7
Silver-haired bat	2	a; b; j; k; l; m; n; p; q; s; t; u; w; z; aa; ab; ac; ad; ae; af	1.1.14; 1.2.12; 2.3; 4.6.1; 4.7.1; 4.7.2; 8.11; 8.12.2; 8.12.3; 8.4
Solitary sandpiper	2	a; h; i; k; m; n; p; v	1.1.1; 1.1.16; 2.1.1; 2.3; 3.2.3; 3.3.6; 4.1.4; 4.1.6; 4.2.1; 4.2.2; 4.2.3; 4.2.4; 4.3; 4.6.1; 4.6.2; 4.7.1; 8.14; 8.17; 8.19.3; 8.25
Spotted bat	1	a; h; i; j; k; m; n; p; u; v	1.2.13; 3.3.2; 3.3.4; 3.3.5; 4.2.1; 4.2.3; 4.2.6; 4.2.9; 4.3; 4.6.1; 8.3
Swainson’s hawk	2	a; c; h; i; k; m; n; v	1.1.14; 1.1.16; 1.2.1; 1.2.10; 1.2.12; 2.1.1; 4.9; 7; 8.12.3; 8.12.4; 8.13; 8.18
Townsend’s big-eared bat	2	a; b; e; j; k; l; m; n; p; q; s; t; u; v; w; x; z; aa; ab; ac; ad; ae; af	1.1.13; 1.1.14; 1.1.16; 1.2.13; 1.2.6; 2.3; 3.3.2; 3.3.3; 3.3.4; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.3; 4.6.1; 4.7.1; 8.11; 8.12.2; 8.12.3; 8.19.1; 8.3; 8.4; 8.6

Common Name	Count of KEFs	Habitat Codes	Key Ecological Correlates
Turkey vulture	1	a; c; h; i; k; l; m; n; q; s; t; u; v; y; z	1.1.1; 1.1.14; 1.2.12; 3.1.2; 3.1.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.4; 4.5; 8.2; 8.6; 8.9
Vaux's swift	1	a; l; m; n; p; q; s; t; u; y; z	1.1.14; 1.2.6; 2.2.2; 8.3
Western pipistrelle	1	a; h; i; j; k; l; m; p; u; v; z; ab	1.1.16; 1.2.13; 3.1.2; 3.1.3; 3.3.2; 3.3.4; 3.3.5; 4.1.8; 4.2.13; 4.2.7; 4.2.9; 4.3; 4.6.1; 8.11; 8.12.2; 8.12.3
Western sandpiper	2	a; h; n; p	2.1.1; 2.1.2; 3.2.3; 3.3.6; 3.3.7; 4.1.2; 4.1.6; 4.2.2; 4.2.3; 4.2.4; 4.3; 4.4; 4.5; 4.6.1; 4.6.2; 4.6.3; 4.7.1; 4.8; 4.9; 8.14; 8.18; 8.19.3; 8.21; 8.23; 8.25
Western screech-owl	2	a; l; m; n; q; s; u; y; z	1.1.14; 4.7.2; 8.10; 8.13
Western wood-pewee	2	a; l; m; t; u; y; z	1.1.14; 1.1.16; 7; 8.1; 8.18
White-throated swift	1	a; h; i; k; l; m; n; p; t; u; v; z	3.3.2; 3.3.5; 8.3; 8.4
Winter wren	2	c; l; m; s; t	1.1.1; 1.1.12; 1.1.14; 1.1.2; 1.1.4; 1.1.5
Wolverine	2	c; s; t; x	3.1.2; 3.1.3; 3.3.1; 3.3.3; 3.3.4; 3.3.5; 3.4.2; 4.1.8; 4.7.2; 8.2; 8.6
Yuma myotis	1	a; b; c; h; i; j; k; l; m; n; p; q; s; t; u; v; w; x; y; z; aa; ab; ac; ad; ae; af	1.1.14; 1.2.12; 1.2.13; 2.1.2; 2.3; 3.3.2; 3.3.3; 3.3.4; 3.3.5; 4.2.1; 4.2.13; 4.2.3; 4.2.7; 4.2.9; 4.6.1; 4.7.1; 8.1; 8.10; 8.11; 8.12.2; 8.12.3; 8.13; 8.17; 8.24; 8.3; 8.4

[a] Habitat Codes: a = agriculture, pasture, and mixed environments (eastside); b = agriculture, pasture, and mixed environs (Westside); d = alpine grasslands and shrublands; e = Ceanothus-Manzanita shrublands; h = desert playa and salt scrub; i = dwarf shrub-steppe; j = eastside (interior) canyon shrublands; k = eastside (interior) grasslands; l = eastside (interior) mixed conifer forest; m = eastside (interior) riparian wetlands; n = herbaceous wetlands; p = lakes, rivers, ponds, and reservoirs; q = lodgepole pine forest and woodlands; s = montane coniferous wetlands; t = montane mixed conifer forest; u = ponderosa pine and eastside white oak forest and woodlands; v = shrub-steppe; w = Southwest Oregon mixed conifer–hardwood forest; x = subalpine parkland; y = upland aspen forest; z = urban and mixed environments (eastside); aa = urban and mixed environs (westside); ab = western juniper and mountain mahogany woodlands; ac = westside grasslands; ad = westside lowland conifer–hardwood forest; ae = westside oak and dry Douglas-fir forest and woodlands; af = westside riparian–wetlands

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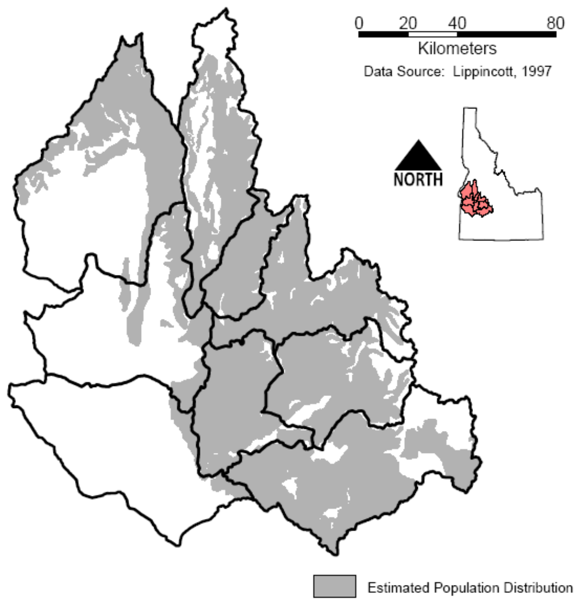
APPENDIX 2-2—TERRESTRIAL FOCAL SPECIES DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

1.1 Columbia Spotted Frog (*Rana luteiventris*)



The Columbia spotted frog occurs in four genetically distinguishable populations in northwestern North America (Green *et al*. 1996, 1997). These disjunct populations are highly fragmented, occurring on isolated mountains and in arid-land springs. Two of these genetically distinguishable populations occur in Idaho: a main population north of the Snake River in central Idaho and portions of the Great Basin population in the Owyhee Mountains of southwestern Idaho. While the main population of spotted frogs appears to be widespread and abundant (Clark *et al*. 1993, Gomez 1994), the Great Basin population appears to be suffering from local extinctions and declines. Consequently, Idaho implemented a long-term monitoring program for the Owyhee Mountain subpopulation (Engle 2000) to determine the status of the Great Basin spotted frog population.

The Columbia spotted frog is a medium-sized frog, reaching lengths of up to 9 cm. Its dorsal ground color ranges from olive green to brown and is marked by spots having irregular borders and light-colored centers. Pigmentation on the frog's abdomen varies from yellow to red, and a light-colored stripe runs along the upper lip. As a tadpole, the spotted frog is generally brownish-green dorsally, with gold flecks. Ventrally, these tadpoles have a silvery color, and their intestines are visible.

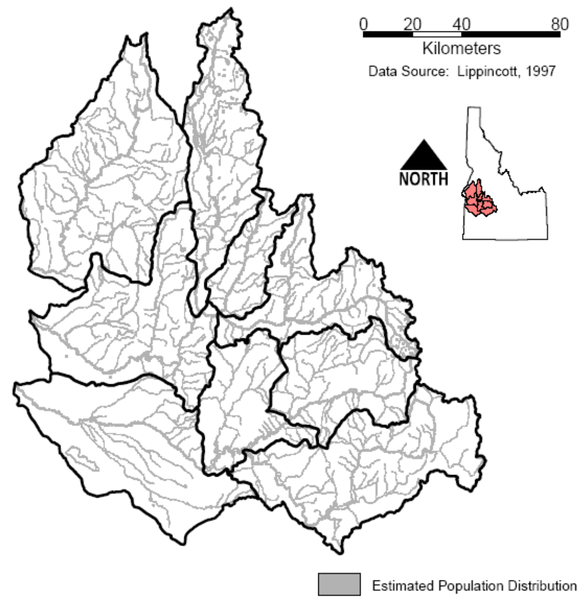
Rangewide, spotted frogs use a variety of habitat types, including coldwater ponds, streams, lakes, and springs adjacent to mixed coniferous and subalpine forest, grassland, and brush land (Morris and Tanner 1969, Stebbins 1985). Spotted frogs are generally found in or near permanent bodies of water. Habitat usually consists of a small spring, pond, or slough with a variety of herbaceous emergent, floating, and submergent vegetation. During summer, these frogs can be found some distance from their aquatic breeding sites but are still associated with moist vegetation (Gomez 1994, Bull and Hayes 2001). Engle and Munger (2000) studied spotted frog movements in the Owyhee Mountains in Idaho and reported that, while five adults moved distances greater than 1,000 meters, most movements were under 500 meters. Morris and Tanner (1969) suggest that deep silt or muck bottoms are required for winter hibernation and torpor.

Columbia spotted frog populations begin breeding in early March and continue through late April. Breeding usually begins with a male vocalizing, stimulating the other males to call simultaneously. The vocalization is described as a "clicking" noise or a soft "bubbling" sound (Morris and Tanner 1969, Stebbins 1985). Egg masses are deposited in open, shallow areas near the shoreline. It has been reported that the frogs deposit eggs in the same area annually (Morris and Tanner 1969, Nussbaum *et al*. 1983). The egg masses are not attached to vegetation and float freely in the water (Ross *et al*. 1993, 1994). Depending on water temperature, the eggs will hatch tadpoles in 10 to 21 days. The Columbia spotted frog remains in the tadpole stage for two to three months before undergoing metamorphosis into an adult frog. Preliminary skeletochronological work indicates that Columbia spotted frogs can live at least 9 years in southwestern Idaho (Engle and Munger 1998).

The spotted frog is an opportunistic forager that eats a wide variety of insects as well as different mollusks, crustaceans, and arachnids (Miller 1978, Whitaker *et al*. 1982, Licht 1986). Larvae eat algae, organic debris, plant tissue, and minute water-borne organisms.

Nonindigenous bullfrogs and fish are probably a primary cause of declining populations of spotted frogs (Storm 1966, Nussbaum *et al*. 1983, McAllister *et al*. 1993). Introduced fishes, particularly warmwater species such as largemouth bass (*Micropterus salmoides*), sunfish (*Lepomis* spp.), perch (*Perca* spp.), and bullhead catfish (*Ictalurus* spp.), prey on both spotted frog tadpoles and adults (Hayes and Jennings 1986). In addition, residential developments have altered or eliminated wetlands and introduced a wide array of contaminants to many aquatic systems. Habitat loss and alteration have also resulted in increased isolation of remaining spotted frog populations and habitats.

1.2 Willow Flycatcher (*Empidonax traillii adastus*)



The willow flycatcher is a common migratory bird that breeds in a variety of riparian habitats. Willow flycatchers overwinter in southern Mexico and northern South America in habitats similar to those occupied on the breeding grounds. There are five subspecies of E. *traillii*, but only *E. traillii adastus* is found in the Boise, Payette, and Weiser subbasins (IBIS, 2003).

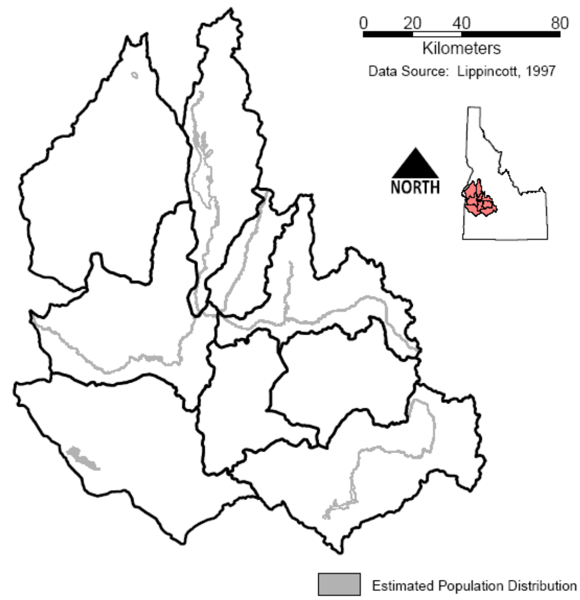
A small bird, the willow flycatcher is between 13 and 17 cm long (Godfrey 1986) and weighs, on average, 16 g (Dunning 1984). The bird has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. It has a distinctive eye ring and white wing bars. The bill is dull yellow-orange or pinkish on the lower mandible and blackish on the maxilla. The sexes are similar in appearance, except during the breeding season when females develop a brood patch.

The willow flycatcher breeds between early May and late July. The female selects a nesting site and builds the nest while the male perches nearby (Gorski 1969). Generally, the nest is built low in the crotch of a bush or small tree near water (Hoffmann 1927). Female willow flycatchers lay between three and four eggs, occasionally five (Holcomb 1974). Eggs are incubated for about 14 days (McCabe 1991), and the female generally performs all incubation duties (McCabe 1963, 1991). Both adults feed the young, but the female plays a major role (Holcomb 1972, McCabe 1991). The chicks fledge at about 14 to 15 days from hatch. The first few days after fledging, fledglings often huddle together on the same perch and remain near the nest for 3 or 4 days; they then follow the adults until 24 to 25 days old (Walkinshaw 1966). Willow flycatchers begin breeding their first year and may live for up to 11 years (Sedgwick 2000).

Predators of the willow flycatcher include the Cooper's hawk (*Accipiter cooperii*), great horned owl (*Bubo virginianus*), red squirrel (*Tamiasciurus hudsonicus*), striped skunk (*Mephitis mephitis*), and fox (*Vulpes* spp.). Most nest predation is believed to be mammalian, including the long-tailed weasel (*Mustela frenata*), the mink (*M. vison*), and voles (*Microtus* spp.) (Paxton *et al*. 1997, Stoleson and Finch 1999). Mule deer may trample some nests, or, when grazing in riparian vegetation, cattle may knock over nests (King 1955, Valentine *et al*. 1988).

Because the willow flycatcher is restricted to streams and river corridors, it is vulnerable to human activities that may alter or change such habitats, including river dewatering, canalization, overgrazing, dam construction, and urbanization. Willow flycatchers will not even attempt nesting in the absence of water (Johnson *et al*. 1999).

1.3 Bald Eagle (*Haliaeetus leucocephalus*)



The bald eagle is a large bird of prey associated with aquatic ecosystems. The bird historically ranged throughout North America. It was first listed as endangered under the Endangered Species Act (ESA) on March 11, 1967 (32 FR 4001) and then downlisted to threatened on July 12, 1995 (60 FR 35999).

The bald eagle breeds from central Alaska across Canada to Labrador and Newfoundland and south to southern mainland Alaska and the Aleutian Islands (DeGraaf *et al*. 1991). It also breeds in Baja California, central Arizona, and southwestern and central New Mexico, as well as along the Gulf Coast from Texas to Florida (Donohoe 1974, DeGraaf *et al*. 1991). The bald eagle occurs only locally throughout much of the Great Basin (Donohoe 1974). Bald eagles winter in most of their breeding range from southern Alaska and Canada southward (Donohoe 1974, DeGraaf *et al*. 1991). Resident populations are found along the Atlantic, Pacific, and Gulf coasts (Johnsgard 1990).

Bald eagles are capable of breeding in their fifth year of life but may not start to breed until they are 6 or 7 years old (Gerrard *et al*. 1992). The breeding season extends from January through March and can vary with both elevation and latitude. A breeding pair usually mates for life. Females lay a single clutch of one to three eggs. The chicks hatch after an incubation period of 35 days. They fledge between 10 to 12 weeks. Bald eagles live up to 28 years in the wild and up to 36 years in captivity (Green 1985, Johnsgard 1990).

Bald eagles prefer habitat near seacoasts, rivers, large lakes, or other large areas of open water (Peterson 1986). They prefer to nest, perch, and roost in primarily old growth and mature stands of conifers or hardwoods. Eagles usually select the oldest and tallest trees that have good visibility and an open structure and that are near prey (Glinski *et al*. 1983, Johnsgard 1990, Kralovec *et al*. 1992, Garrett *et al*. 1993). A study in Maine showed that eagles preferred areas with “super-dominant” trees. It also showed that they avoided lakes surrounded by dense forest or inhabited by coldwater fishes. Eagles used areas away from human disturbance and selected nesting sites near lakes having abundant warmwater fishes (Livingston *et al*. 1990). Another study showed a preference for nesting near lakes with a circumference greater than 7 miles (11 km). The smallest body of water supporting a nesting pair of bald eagles was 20 acres (8 ha) (Peterson 1986).

Eagles choose sites more than 0.75 mile (1.2 km) from low-density human disturbance and more than 1.2 miles (1.8 km) from medium- to high-density human disturbance (Peterson 1986). Wintering bald eagles in New Mexico and Arizona used a disproportionate amount of snags in the largest class size (no d.b.h. given) for perching and usually perched in the top one-third of these trees. For roosting, eagles preferred the largest live trees having open structures for visibility (Grubb and Kennedy 1982).

Habitat suitability index models have been developed for wintering bald eagles in lacustrine and estuarine habitats of the central and northern states (Peterson 1986). Bald eagles need old growth or late-successional forests for nesting and roosting (Lehmkuhl and Ruggiero 1991). Nest snags must be sturdy to support nests. Tree height or species is not as important as the abundance of comparatively large trees near feeding areas (Glinski *et al*. 1983). Lakes greater than 3.8 square miles (10 km^2) may be optimal for breeding bald eagles, although longer and narrower bodies of water can support breeding pairs. Nest trees should have an open form and sturdy branches in the upper one-third of the tree. Eagles nest in the overstory. Forests used for nesting should have a canopy cover of less than 60% (may be as low as 20%) and be near water (Snyder 1993). In treeless areas, bald eagles nest on cliffs or on the ground (Peterson 1986).

Roosting sites need not be as near to water as nesting sites. It is more important that roosting sites are in dense stands of old growth that offers protection from weather. Eagles usually arrive at roost sites after dark and depart from them before dawn. It is therefore difficult to determine important roost sites by observing eagles during daylight hours (Grubb and Kennedy 1982).

Average home ranges for eight pairs of bald eagles in Oregon were 1,650 acres (660 ha), with an average distance between nest territories of 2 miles (3.2 km) and an average of 0.3 mile (0.5 km) of shoreline per pair (Johnsgard 1990). In Arizona, the estimate for home range was 24.6 square miles (64 km^2), with 9.4 to 11.2 miles (15–18 km) of shoreline for each pair.

Bald eagles eat fish, reptiles, birds, mammals, invertebrates, and carrion, including livestock carrion. Some food species of eagles include bullhead fish (*Ictalurus* spp.), alewife (*Alosa pseudoharengus*), chain pickerel (*Esox niger*), sucker (*Catostomus* spp.), salmon (*Oncorhyncus* spp.), white perch (*Morone americana*), smallmouth bass (*Micropterus dolomieui*), eel (*Anguilla rostrata*), sea otter (*Enhydra lutris*), Grebe (*Podilymbus Spp.*), Canada goose (*Branta canadensis*), American coot (*Fulica americana*), mallard (*Anas platyrhynchos*), pintail (*A. acuta*), hare (*Lepus* spp.), and prairie dog (*Cynomys* spp.) (Peterson 1986, Kralovec *et al.* 1992, Livingston *et al*. 1990).

Eggs, nestlings, and fledglings are most vulnerable to predators. Reported predation of eggs in tree nests is by black-billed magpies (*Pica pica*), gulls (*Larus* spp.), ravens and crows (*Corvus brachyrynchos* and *C. corax*), black bears (*Ursus americanus*), bobcats *Felis rufus*), wolverines (*Gulo gulo*), and raccoons (*Procyon lotor*) (Chrest 1964, Hensel and Troyer 1964, Sprunt and Ligas 1964, McKelvey and Smith 1979, Nash *et al*. 1980). Few nonhuman species are able or likely to prey on immature or adult bald eagles (Buehler 2000), except when the bird is in the nest. Fledglings on the ground are vulnerable to mammalian predators.

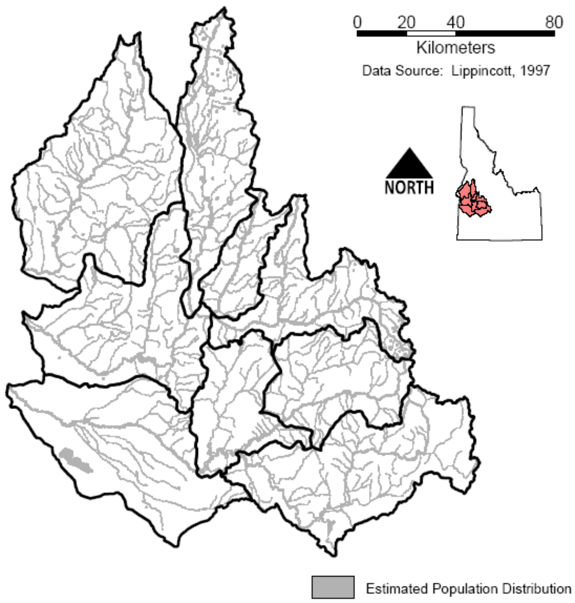
Humans pose the greatest threat to bald eagles through habitat destruction, pesticide use, and poaching (Buehler *et al*. 1991). Bald eagles are flushed, in order of increasing ease, from perches, nests, and foraging areas by human disturbance (Grubb and King 1991). They are most easily disturbed by pedestrian traffic and least disturbed by aircraft. Establishing buffer zones of 148 to 296 feet (400–800 m) in Oregon and 167 to 592 feet (450–1,600 m) in the Southeast was recommended to reduce the impact of human disturbance on nesting pairs (Grubb and King 1991).

Silvicultural treatments for maintaining eagle habitat in ponderosa pine (*Pinus ponderosa*) of various age and structure, subclimax mixed conifer, Douglas-fir (*Pseudotsuga menziesii*), and oak (*Quercus lobata*; *Q. kellogii*) stands in northeastern California have been detailed (Burke 1983).

Because forest structure (density and height class) determines avian community composition, changes in forest structure lead to changes in avian communities (Diem and Zeveloff 1980, Smith 1980). A stand-replacing fire will, therefore, likely change bald eagle use of a forest. Fires that destroy old growth forest can reduce eagle populations (Yellowstone National Park 1991). If low-intensity, litter-reducing fires are not allowed to burn in old growth forests, stand-replacing, high-intensity crown fires can result (Covington and Moore 1992).

Fires create snags, which are important perching and nesting sites for bald eagles. Snags can possibly increase potential for lightning-caused fire when standing, and when fallen, they increase fuel loading (Lyon 1977). These increased potentials may be hazardous in areas where fire control for maintaining bald eagle populations is necessary. There have been no studies to determine whether the hazards of snags outweigh their benefits to eagles. Snag attrition rates have been listed for lodgepole pine forests following fire (Lyon 1977). Old growth eastern white pine (*Pinus strobus*) forests in Ontario continually recruit snags in the absence of fire because of their uneven-aged structure (Quinby 1991). Fires in mature and old growth forests can create even-aged conditions that may stop continuous snag recruitment (Quinby 1991).

1.4 American Beaver (*Castor canadensis*)



The American beaver (*Castor canadensis*) is found throughout the Boise, Payette, and Weiser subbasins, inhabiting riparian areas of mixed coniferous-deciduous forests and deciduous forests containing abundant beaver foods and lodge-building material such as quaking aspen (*Populus tremuloides*), willows (*Salix* spp.), alders (*Alnus* spp.), redosier dogwood (*Cornus sericea*), and cottonwoods (*Populus* spp.) (Patric and Webb 1953, Allen 1983). Suitable habitat for beavers must contain all of the following: stable aquatic habitat providing adequate water, channel gradient of less than 15%, and quality food species present in sufficient quantity (Allen 1983). Through tree-harvesting activity, beavers can usually control water depth and stability on small streams, ponds, and lakes and can also have an effect on natural succession.

Large lakes or reservoirs (8 ha in surface area) with irregular shorelines provide optimum habitat for beavers. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level are generally unsuitable habitat for beavers (Allen 1983, Smith and Peterson 1991). Intermittent streams or streams that have major fluctuations in discharge have little year-round value as beaver habitat (Allen 1983). Food availability is another factor determining suitable habitat for beavers (Harris 1991). Beavers often occupy marshes, ponds, and lakes when an adequate supply of food is available. They generally forage no more than about 90 meters from water, though foraging distances of up to 200 meters have been reported (Allen 1983).

In Idaho, beavers breed between mid-January and early June (Lippincott 1997). Beavers are generally monogamous, although males will mate with other females (Van Gelden 1982, Merritt 1987). Only the dominant female of a beaver colony breeds, producing one litter a year (Van Deelen 1991). The gestation period is four months, with the average litter size varying between two and three kits (Rue 1967, Van Gelden 1982, Zeveloff 1988, Van Deelen 1991). Kits are weaned at two to three months and can swim by one week of age (Van Gelden 1982, Zeveloff 1988). Beavers become sexually mature between ages two and three (Lawrence 1954, Wilkinson 1962). They live up to 11 years in the wild and between 15 and 21 years in captivity (Rue 1967, Merritt 1987).

Beavers are active throughout the year and usually nocturnal. They live in colonies (average five beavers per colony) that consist of three age classes: adults, kits, and yearlings that were born the previous spring (Lawrence 1954). After young beavers reach their second or third year, they are forced to leave the family group (Lawrence 1954, Merritt 1987, Zeveloff 1988). Dispersal may be delayed in areas with high beaver densities. Subadults generally leave the natal colony in late winter or early spring (Van Deelen 1991). Subadult beavers have been reported to migrate as far as 236 km, although average migration distances range from 8 to 16 km (Allen 1983). Adult beavers are nonmigratory (Allen 1983).

Beavers are herbivores. During late spring and summer, their diet consists mainly of fresh herbaceous matter (Allen 1983, Lawrence 1954). Beavers appear to prefer herbaceous vegetation to woody vegetation during all seasons if it is available. Woody vegetation may be consumed during any season, although its highest utilization occurs from late fall through early spring when herbaceous vegetation is not available. The majority of the branches and stems of woody vegetation are cached for later use during winter (Allen 1983). Trees and shrubs closest to the water's edge are generally used first (Allen 1983).

Winter is a critical period, especially for colonies on streams because they must subsist solely on their winter food caches. In contrast with stream colonies, those on lakes are not solely dependent on their stores of woody vegetation; they can augment their winter diet of bark with aquatic plants (Lawrence 1954).

Aquatic vegetation such as duck-potato (*Sagittaria latifolia*), duckweed (*Lemma* spp.), pondweed (*Potamogeton* spp.), and waterweed (*Elodea* spp.) are preferred foods when available (Allen 1983). The thick, fleshy rhizomes of water lilies (*Nymphaea* spp. and *Nuphar* spp.) may be used as a food source throughout the year. If present in sufficient amounts, water lily rhizomes may provide an adequate winter food source, resulting in little or no tree cutting or food caching of woody materials (Lawrence 1954, Allen 1983). Other important winter foods of beavers living on lakes include the rhizomes of sedges and the rootstocks of mat-forming shrubs (Lawrence 1954).

Aspen and willows are considered preferred beaver foods; however, these species are generally riparian species and so may be more available for beaver foraging but not necessarily preferred over all other deciduous tree species. Beavers have been reported to subsist in some areas by feeding on conifer trees, but these trees are a poor-quality food source (Allen 1983).

The lodge is the major source of escape, resting, thermal, and reproductive cover for beavers. Beavers usually construct lodges so that the structure is surrounded by water or located against a bank. Water protects the lodge from predators and provides concealment for beavers when traveling to and from food-gathering areas and caches (Allen 1983). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, waves, and ice (Allen 1983). Damming large streams that have swift, turbulent waters creates calm pools for feeding and resting (Harris 1991).

Beavers have few natural predators; however, in certain areas, they may face predation pressure from wolves (*Canis lupus*), coyotes (*Canis latrans*), lynx (*Lynx canadensis*), fishers (*Martes pennanti*), wolverines (*Gulo gulo*), and occasionally bears (*Ursus* spp.). Minks (*Mustela vison*), otters (*Lutra canadensis*), hawks, and owls periodically prey on kits (Rue 1967, Merritt 1987). Humans kill beavers for their fur (Lawrence 1954, Merritt 1987).

However, beavers will live near people if all habitat requirements are met (Rue 1967). Railways, roads, and land clearing adjacent to waterways may affect beaver habitat suitability. Transplants of beaver may be successful on strip-mined land or in new impoundments where water conditions are relatively stable. Highly acidic waters, which often occur in strip-mined areas, are acceptable for beaver if suitable foods are present (Allen 1983).

Beaver activity can have a significant influence on stream and riparian habitats (Munther 1981, Barnes and Dibble 1988, Johnston and Naiman 1990, Van Deelen 1991). Through tree-harvesting activity, beavers can affect natural succession. Other than humans, beavers are the only mammals in North America that can fell mature trees; therefore, their ability to decrease forest biomass is much greater than that of other herbivores (Allen 1983). In addition, beaver ponds conserve spring runoff, thus ensuring more constant stream flow, diminishing floods, conserving soil, and helping maintain the water table (Hazard 1982).

Beaver activity can be beneficial to some wildlife species (Johnson 1989, Van Deelen 1991). Waterfowl often benefit from the increased edge, diversity, and invertebrate communities created by beaver activity (Van Deelen 1991). Occupied beaver-influenced sites produce more waterfowl because of improved water stability and increased brood-rearing cover; waterfowl production declines when beavers leave an area. Great blue herons (*Ardea herodias*), ospreys (*Pandion halietus*), bald eagles (*Haliaeetus leucocephalus*), kingfishers (*Ceryle alcyon*), and many species of songbirds also benefit from beaver activity. Otters, raccoons (*Procyon lotor*), mink, and muskrat (*Ondatra zibithica*) thrive on the increased foraging areas produced by beaver activity. Berry-producing shrubs and brush in areas cut by beavers attract white-tailed deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*) (Van Deelen 1991).

Beaver activity can also improve fish habitat. Production of three trout species (*Salmo* spp. and *Salvelinus fontinalis*) in a stream in the Sierra Nevada increased due to a higher standing crop of invertebrates in beaver ponds (Gard 1961). Smallmouth bass (*Micropterus dolomieuis*) and northern pike (*Esok lucius*) also benefit from beaver impoundments (Van Deelen 1991). In some instances, beaver ponds have provided up to six times more salmonids (by total weight) per acre than adjacent stream habitat without beaver ponds has provided (Munther 1981). In areas of marginal trout habitat, however, beaver activity can reduce trout production. Beaver-caused loss of streamside shade and diminished water velocity can result in lethal water temperatures (Van Deelen 1991).

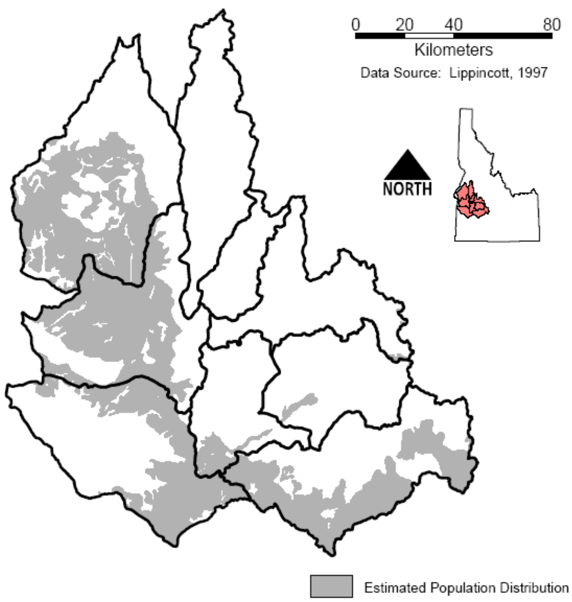
The amount of influence that cattle have on riparian environment can be reduced by beaver activity in many valley bottoms. If beavers are thoroughly established in willow habitats of wide valleys prior to cattle being introduced, the immediate effect of cattle on the stream is often minor (Munther 1981).

Beaver activity can also have detrimental effects. Beaver-caused flooding often kills valuable lowland timber (Van Deelen 1991). Human–beaver conflicts occur when beavers flood roadways and agricultural lands or dam culverts and irrigation systems. Also, beavers have potential to increase waterborne pathogens (including *Giardia lamblia*) downstream of their activity (Van Deelen 1991).

Information about the direct effects that fire has on beavers was not found in the literature; however, beavers can probably easily escape fire (Tesky 1993c). Since lodges are typically built over water, they are probably at little risk of being destroyed by fire. Fire occurring in riparian areas often benefits beaver populations (Kelleyhouse 1979). Beavers are adapted to the early stages of forest succession. Quaking aspen, willows, alders, and redosier dogwood—prime beaver food trees—all sprout vigorously after fire. As succession progresses, these trees become too large for beavers to use or are replaced by climax trees (Wright and Bailey 1982). Recurring fires within parts of boreal forests have allowed aspen and willow to replace coniferous forests. This change favors beaver populations since willow and aspen are important food sources.

2 Shrub-Steppe

2.1 Greater Sage-Grouse (*Centrocercus urophasianus*)



The greater sage grouse historically inhabited much of the sagebrush-dominated regions of North America. The species is renowned for its spectacular breeding displays, during which large numbers of males congregate to perform a strutting display (Johnsgard 1973). Today, sage-grouse populations are declining throughout most of their range, mostly due to habitat loss and degradation (Hays *et al*. 1998).

Sage grouse are relatively large, with the males being larger than the females. Males weigh 3.75 to 6.4 pounds (1.7–2.9 kg) and are 26 to 30 inches (65–75 cm) long; females weigh 2.2 to 4 pounds (1.0–1.8 kg) and are 19.7 to 23.6 inches (50–60 cm) long (Schroeder *et al.* 1999). Both sexes have narrow, pointed tails; feathering to the base of the toes; a variegated pattern of grayish brown, buffy, and black on the upper parts of the body; and a black belly (Johnsgard 1973). Males are more colorful than females and have a black throat and bib; scaly, white foreneck plumage; and a large, white ruff on the breast (Dunn *et al*. 1987). Males also exhibit two large, frontally directed air sacs of olive-green skin and yellow superciliary combs that enlarge during breeding display (Johnsgard 1973, Udvardy 1977). Sage grouse are thought to live up to 10 years in the wild, but in one study, the average life span of sage grouse in both hunted and protected populations was 1 to 1.5 years (Elman 1974); in another study, sage grouse 3 to 4 years of age were considered old (Wallestad 1975).

Female sage grouse are sexually mature their first fall and nest the following spring (Patterson 1952). Males are sexually mature the spring following their first winter. Yearling males engage in display and breeding but devote less time and energy to courtship activities than adults do (Wiley 1974).

In early April, male and female sage grouse gather for displaying and mating at specific locations, called leks. At the beginning of the breeding season, male sage grouse establish small territories on the lek. The males occupying territories near the center of the lek may be more successful at mating (Davis 1978). After mating, sage-grouse hens leave the lek to nest. Most hens build nests under shrubs (Jarvis 1974, Wallestad and Pyrah 1974, Roberson 1984), specifically in areas with medium-high shrub cover and residual grass (i.e., dry grass from the previous growing season) (Schoenberg 1982, Gregg 1991, Sime 1991). Hens incubate 7 to 15 eggs for about 25 to 27 days (Connelly *et al*. 1991). After hatching, chicks wait until they are dry before they leave the nest. Sage-grouse hens attempt to raise one brood in a season (Girard 1937). The chicks feed themselves, but hens spend considerable time keeping chicks warm and guarding them for the first four to five weeks (Patterson 1952).

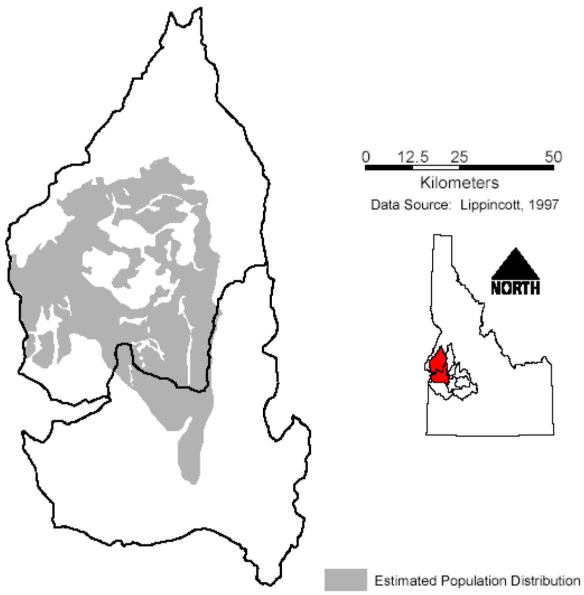
Sage grouse usually roost on the ground from evening until early morning, feed and rest during the afternoon, and return to their roosting site at night (Johnsgard 1973). Sage-grouse use shrub stands with medium to very high shrub cover primarily for foraging and loafing (Autenrieth 1981, Emmons and Braun 1984, Roberson 1984).

Sagebrush, grasses, forbs, and insects comprise the annual diet of sage grouse. Sagebrush comprises 60 to 80% of the yearly diet of adult sage grouse (Patterson 1952, Wallestad *et al*. 1975, Remington and Braun 1985) and as much as 95 to 100% of the winter diet (Roberson 1984). Forbs may constitute 50% of the diet of juveniles up to 11 weeks of age (Klebenow and Gray 1968, Peterson 1970). Forbs also appear to be important to nesting hens in the pre-laying period (Barnett and Crawford 1993). Insects make up 50% of the diet during the first and second week of life (Patterson 1952, Klebenow and Gray 1968, Peterson 1970). Johnson and Boyce (1990) found that chicks younger than 3 weeks old required insects for survival and chicks older than 3 weeks had reduced growth rates when insects were removed from the diet.

Some researchers consider water a key component of sage-grouse habitat (Carr 1967, Savage 1969, Call and Maser 1985). Others have found no evidence that sage grouse prefer sites close to water (Wallestad 1975, Autenrieth 1981, Cadwell *et al*. 1994). Sage grouse need to consume water, but they typically obtain enough water by consuming vegetation that stores water, such as succulent forbs. Sage grouse may concentrate in late summer and fall where water or succulent forbs are available. Water sources include streams, springs, water holes, and cattle troughs. Where water is available, sage grouse normally visit water sites in the morning and evening. Sage-grouse that occupy areas with little precipitation may migrate to areas containing water during summer and fall. Chicks require water soon after hatching (Girard 1937), so hens with broods often migrate to areas containing water. Petersen (1980) found that hens with broods remained in upland habitat until succulent forbs disappeared; then they moved to wet meadows in late summer.

Sources of mortality of sage grouse include predation, weather, accidents, disease and parasitism, and environmental hazards such as pesticides. These natural and human-influenced factors become more important management issues with small populations. Blus *et al*. (1989), for instance, found organophosphorus insecticides (dimethoate or methamidophos) directly responsible for the death of sage grouse that occupied or were near sprayed alfalfa or potato fields in southeastern Idaho. Predation is a limiting factor throughout the annual sage-grouse cycle, but its severity depends on habitat quality. Raptors and crows are the primary predators of sage grouse (Patterson 1952, Lumsden 1968, Wiley 1973), while coyotes (*Canis latrans*), bobcats (*Lynx rufus*), minks (*Mustela vison*), badgers (*Taxidea taxus*), and ground squirrels (*Spermophilus* spp.) are the most important ground predators. Weather can influence nesting success and survival of young chicks (Dalke *et al*. 1963, Autenreith 1981). Diseases and parasites do not appear to be a significant source of mortality (Girard 1937, Batterson and Morse 1948).

2.2 Sharp-tailed Grouse (*Tympanuchus phasianellus*)



The sharp-tailed grouse is found from north-central Alaska, the Yukon Territory, Northwest Territories, northern Manitoba, northern Ontario, and central Quebec south to eastern Washington, northeast Utah, and Colorado. It occurs in the Great Plains from eastern Colorado to northern Minnesota, northern Wisconsin, and northern Michigan (Johnsgard 1983). The Columbian sharp-tailed grouse (*T. phasianellus columbianus*) is a resident from northern British Columbia south to eastern Washington, western Montana, northern Utah, and western Colorado (CDFG 1992). Columbian sharp-tailed grouse range formerly extended to California, Nevada, and New Mexico (Irving 1950, Marks and Marks 1988).

The species was previously classified as a category 2 (C2) candidate under the ESA (USFWS 1994). In 1996, the U.S. Fish and Wildlife Service dropped category 2 from the candidate list. The species is currently categorized as sensitive by both the Bureau of Land Management and U.S. Forest Service.

The sharp-tailed grouse is a medium-sized grouse of the western prairies and plains. Adults are 15 to 20 inches (38–50 cm) long. They have a buff-colored, pale breast, a speckled brown back, and a dominant black eye stripe. The displaying males inflate purple- and pink-colored air sacs and dance at mating grounds called leks. The pointed tail for which the bird is named shows white on the sides during flight.

Columbian sharp-tailed grouse are typically found in sagebrush semi deserts (Prose 1987). Of the nine cover types near Mann Creek in western Idaho, Columbian sharp-tailed grouse used big sagebrush (*Artemisia tridentata*) types more than or in proportion to availability, used low sagebrush (*A. arbuscula*) in proportion to availability, and avoided shrubby eriogonum (*Eriogonum* spp.) cover types. Columbian sharp-tailed grouse selected areas with greater density and coverage of arrowleaf balsamroot (*Balsamorhiza sagittata*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) in big sagebrush sites (Marks and Marks 1988). Columbian sharp-tailed grouse broods in Wyoming were found most often (73%) in mountain shrub and sagebrush-common snowberry (*Symphorocarpus albus*) habitats (Klott and Lindzey 1990).

Sharp-tailed grouse are a true lek species: males defend small territories on traditional “dancing grounds” where they compete for mating opportunities. Typically, only a few males mate. The height of male displaying occurs in spring (Marks and Marks 1988). The female begins to make a nest at about the same time, or possibly even before, she begins to visit the dancing grounds. After successfully mating, she leaves the dancing grounds and probably does not return. Males also display at dancing grounds during autumn. This display is thought to recruit first-year males into the lekking group and maintain or improve territorial position among established males (Johnsgard 1983).

Young male sharp-tailed grouse probably begin establishing peripheral territories in the first autum of their life, and these territories are held again the following spring (Johnsgard 1983). Females probably breed for the first time as yearlings (Gratson 1988).

Sharp-tailed grouse generally lay up to 12 eggs at a rate of one per day. Incubation begins when the last egg has been laid. The incubation period is 23 to 24 days. The precocial young all hatch on the same day (Johnsgard 1983, Marks and Marks 1988). Renesting attempts sometimes occur but probably contribute no more than 10% of the offspring in an average season (Johnsgard 1983). After the young hatch, they are led away from the nest. Chicks are able to fly to a limited degree when they are 10 days old, and they rapidly become independent. By the time they are 6 to 8 weeks old, they are fully independent, and broods gradually break up and disperse (Johnsgard 1983). The maximum known life span is 7.5 years (Arnold 1988).

A common characteristic of sharp-tailed grouse leks is low, sparse vegetation that allows for good visibility and unrestricted movement (Prose 1987). Height and density of vegetation appear to be important factors in selection of leks (Gregg 1987). Sharp-tailed grouse leks have been reported on mowed wet meadows, cattle-trampled areas around windmills, low ridges and knolls, and recent burns (Prose 1987). Leks are often located relatively close to dense herbaceous cover from the previous year's growth ("residual" cover) (Prose 1987).

Sharp-tailed grouse nest on the ground, preferably among tall, rank grasses, but may also nest in brushy or woody areas. Residual herbaceous vegetation is important nesting cover because little current growth is available in early spring when most nests are constructed (Prose 1987). Female sharp-tailed grouse usually do not travel far from leks to nest if suitable cover is available.

Favored brooding sites are those that contain relatively dense herbaceous cover associated with a mixture of shrubs and forbs (Johnsgard 1983). Broods use cultivated lands, which are generally avoided before nesting (Gregg 1987). Openings in forested areas may also be used (Hamerstrom 1963, Johnsgard 1983). Woody cover is more important for broods than for nesting hens (Miller 1963).

After the mating season, males gradually move away from their leks to foraging and daytime roosting sites that usually include brushy cover, aspen or willow thickets, or young conifer stands. In Utah, during the day, sharp-tailed grouse roosted in weeds and grass during June and early July and in shrubs and bushes in late July and August. Sharp-tailed grouse prefers night roosts located in fairly open upland sites with good ground cover to roosts in marsh and bog vegetation (Johnsgard 1983).

Winter use of habitats varies with snow depth (Swenson 1985). As food and cover are reduced in open habitats, sharp-tailed grouse move into woody vegetation (Johnsgard 1983, Prose 1987). Sharp-tailed grouse also dig snow burrows for shelter if snow depth is adequate; death may occur in severe weather if no snow is available for burrowing (Johnsgard 1983).

The growth form of dominant grasses is important in late winter habitat. In late winter and early spring, when shrub canopies are open and dry snow is unavailable for burrowing, heavy or deep (> 4 inches [10.2 cm]) snow may collapse sod-forming grasses. Bunchgrasses are more resistant to collapsing under heavy snow and can provide cover when snow is up to 12 inches (30.5 cm) deep (Prose 1987).

Good-quality grass and brushy cover are essential for sharp-tailed grouse. The height and density of vegetation is generally more important than species composition in determining sharp-tailed grouse habitat quality (Prose 1987). Sharp-tailed grouse prefer areas that contain cover that is in scattered openings rather than evenly distributed (Miller 1963). Scattered shrubs and shrubby breaks are more important during late summer and fall than they are in midsummer when grass height is sufficient. Woody vegetative cover generally becomes increasingly important during fall and winter (Prose 1987).

For the Columbian sharp-tailed grouse, shrubs and small trees are important habitat components only during late fall and winter. During the rest of the year, weed-grass cover and cultivated crops such as wheat and alfalfa provide important food and cover (Johnsgard 1983).

Sharp-tailed grouse are primarily herbivorous and utilize a variety of leafy plant material including buds, fruits, and catkins of woody species. During the spring and summer, herbaceous plants make up the bulk of the sharp-tailed grouse diet. During fall and winter, sharp-tailed grouse rely more on woody species (Johnsgard 1983, Prose 1987). Sharp-tailed grouse younger than 10 weeks old feed primarily on insects such as short-horned and long-horned grasshoppers, beetles, and ants. At 12 weeks of age, they consume about 90% plant material, a percentage that closely resembles that of the adult diet (Prose 1987).

During spring and summer in Washington, green herbaceous materials composed the bulk of the sharp-tailed grouse diet; grass blades alone (especially Sandberg bluegrass [*Poa secunda*]) totaled 50% of the spring diet and 75% of the summer diet. Flower parts, particularly those of dandelion (*Taraxacum officinale*) and buttercup (*Ranunculus* spp.), made up the rest of the spring and summer food (Johnsgard 1983). The summer diet of adult plains sharp-tailed grouse in the Nebraska sandhills was 91% plant material, 5% insects, and 4% unknown. Important food items by volume included 54% clover (*Trifolium* spp.), 9% rose hips (*Rosa* spp.), 6% Bessey cherry (*Prunus besseyi*), 4% dandelion, and 3% eastern poison ivy (*Toxicodendron radicans*) (Prose 1987).

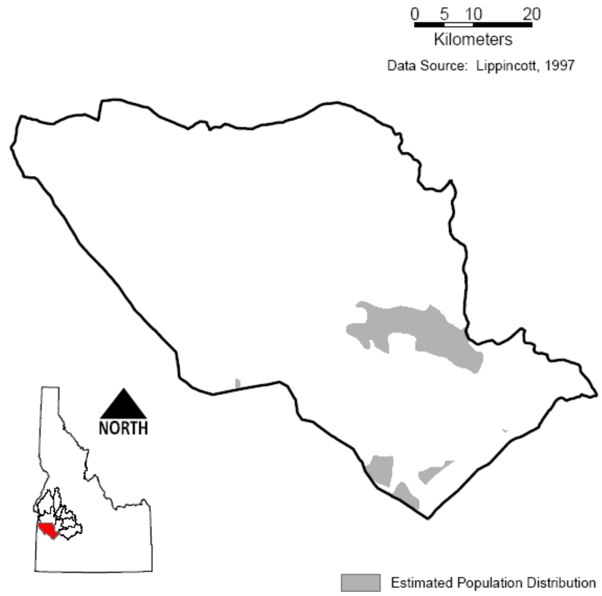
During fall, a diverse array of seeds and cultivated grains are eaten, especially in agricultural areas. In nonagricultural areas, shrub fruits and seeds and green leaves of herbs, shrubs, and trees are eaten (Johnsgard 1983). The October diet of 53 plains sharp-tailed grouse showed a similar emphasis on plant items (89%), including heavy use of fruits. Important plant foods during this period were rose (46%), clovers, (16%), American nightshade (*Solanum americanum*) (11%), clammy groundcherry (*Physalis heterophylla*) (7%), dandelion (3%), and western snowberry (*Symphoricarpos occidentalis*) (2%). Insects comprised 8% of the October diet (Prose 1987).

Availability of grain, fruiting shrubs, or deciduous trees is important in winter. Paper birch (*Betula papyrifera*) and quaking aspen are major winter food sources for prairie sharp-tailed grouse when snow cover prevents foraging on grains or similar foods (Johnsgard 1983). The fruits of black hawthorn (*Crataegus douglasii*) and the buds of Saskatoon serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*) were the main winter foods of Columbian sharp-tailed grouse in western Idaho (Marks and Marks 1988).

Some predators of sharp-tailed grouse include red foxes (*Vulpes vulpes*), coyotes (*Canus latrans*), and great horned owls (*Bubo virginianus*) and other raptors (Gratson *et al*. 1990).

The populations and distributions of the Columbian, prairie, and plains sharp-tailed grouse have all decreased from loss of habitat due to intensive livestock grazing, conversion of range to cropland, and other human activities (Johnsgard 1983). Overstocking results in loss of vegetation necessary for nesting and may reduce shrubby cover needed for broods. Woody vegetation frequently deteriorates in areas where livestock are concentrated. In such areas, it would be desirable to fence off some woody stands to provide cover for sharp-tailed grouse (Sisson 1976, Marks and Marks 1988). In western Idaho, mountain shrub and riparian cover types were the most important winter habitats for Columbian sharp-tailed grouse. These cover types are sometimes heavily damaged by livestock. Any disturbance that may damage or eliminate these cover types may have severe negative impacts on Columbian sharp-tailed grouse (Marks and Marks 1988). In general, grazing should be regulated so that approximately 15% of an area remains unused during a season (Sisson 1976).

2.3 Pygmy Rabbit (*Brachylagus idahoensis*)



The range of the pygmy rabbit includes most of the Great Basin and some of the adjacent intermountain areas of the western United States (Green and Flinders 1980a). Pygmy rabbits are typically found in areas of tall, dense sagebrush (*Artemisia* spp.) cover and are highly dependent on sagebrush to provide both food and shelter throughout the year. The species is highly vulnerable to rapid population declines because of its close association with specific components of the sagebrush ecosystem. Currently, only populations of pygmy rabbits in the Washington Columbia Basin area are listed as endangered (November 30, 2001, 68 FR 10388) under the Endangered Species Act (ESA).

Pygmy rabbits are capable of breeding when they are about one year old (Wilde and Keller 1978, Green and Flinders 1980a). The breeding season of pygmy rabbits is very short. In Idaho, it lasts from March through May. The gestation period of pygmy rabbits is unknown; it is between 27 and 30 days in various species of cottontails (*Sylvilagus* spp.). An average of six young are born per litter, and a maximum of three litters are produced per year (Green and Flinders 1980a). In Idaho, the third litter is generally produced in June (Wilde and Keller 1978). It is unlikely that litters are produced in the fall (Green and Flinders 1980a).

The growth rates of juveniles are dependent on the date of birth. Young from early litters grow larger due to a longer developmental period prior to their first winter (Green and Flinders 1980a). The mortality of adults is highest in late winter and early spring. Green and Flinders (1980a) reported a maximum estimated annual adult mortality of 88% in Idaho. Juvenile mortality was highest from birth to five weeks of age (Green and Flinders 1980a).

Pygmy rabbits may be active at any time of day, but they are generally most active at dusk and dawn (Tesky 1994). They usually rest near or inside their burrows during midday (Green and Flinders 1980b). Pygmy rabbits are generally limited to areas on deep soils with tall, dense sagebrush that they use for cover and food (Green and Flinders 1980b, Flath 1994). Individual sagebrush plants in areas inhabited by pygmy rabbits are often 1.8 (or more) meters tall (Flath 1994). Extensive, well-used runways interlace the sage thickets and provide travel and escape routes (Green and Flinders 1980a). Dense stands of big sagebrush along streams, roads, and fencerows provide dispersal corridors for pygmy rabbits (Weiss and Verts 1984).

The pygmy rabbit is the only native leporid that digs burrows (Tesky 1994). Juveniles use burrows more than other age groups. Early reproductive activities of adults may be concentrated at burrows (Green and Flinders 1980a). When pygmy rabbits can utilize sagebrush cover, burrow use is decreased. Pygmy rabbits use burrows more in winter for thermal cover than at other times of the year (Wilde and Keller 1978).

Burrows are usually located on slopes at the base of sagebrush plants and face north to east (Tesky 1994). Tunnels widen below the surface, forming chambers, and extend to a maximum depth of about 1 meter. Burrows typically have 4 or 5 entrances but may have as few as 2 or as many as 10 (Green and Flinders 1980a). Site selection is probably related to ease of excavating burrows (Weiss and Verts 1984). In areas where soil is shallow, pygmy rabbits live in holes among volcanic rocks, in stonewalls, around abandoned buildings, and in burrows made by badgers (*Taxidea taxus*) or marmots (*Marmota flaviventris*) (Bradfield 1975, Green and Flinders 1980a). Some researchers have found that pygmy rabbits never venture further than 21.3 meters from their burrows (Bradfield 1975). However, Bradfield (1975) observed pygmy rabbits range up to 100 meters from their burrows.

Some areas inhabited by pygmy rabbits are covered with several feet of snow for up to two or more months during winter. During periods when the snow has covered most of the sagebrush, pygmy rabbits tunnel beneath the snow to find food (Tesky 1994). Snow tunnels are approximately the same height and width as underground burrows and are quite extensive, extending from one sagebrush plant to another (Bradfield 1975, Green and Flinders 1980). Aboveground movement during winter months is restricted to these tunnel systems (Bradfield 1975). Pygmy rabbits are restricted to areas with heavy shrub cover (Green and Flinders 1980, Flath 1994). Pygmy rabbits are seldom found in areas of sparse vegetative cover and seem reluctant to cross open space (Bradfield 1975). In southeastern Idaho, woody cover and shrub heights were significantly ($P < 0.01$) greater on sites occupied by pygmy rabbits than on other sites in the same area (Green and Flinders 1980a).

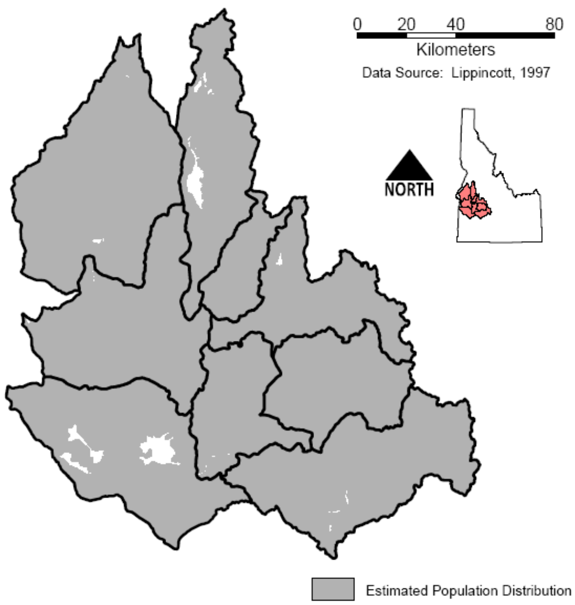
The primary food of pygmy rabbits is big sagebrush, which may comprise up to 99% of the food eaten in winter. Grasses and forbs are also eaten from mid- to late summer (Bradfield 1975, Green and Flinders 1980b, Gates and Eng 1984). In Idaho, Gates and Eng (1984) found that shrubs were 85.2% (unweighted mean) of the pygmy rabbit diet from July to December. Shrub use was lowest in August (73.1%) and highest in December (97.9%). From July to December, big sagebrush was the most important shrub in the diet (54.2%), followed by rubber rabbitbrush (*Chrysothamnus nauseosus*) (25.8%) and winterfat (*Krascheninnikovia lananta*) (4.6%). Grasses made up 10% of the diet during those months, though they were consumed mostly during July and August. Indian ricegrass and needlegrass (*Stipa* spp.) were the most important grasses consumed. Grass and forb consumption was relatively constant throughout the summer (39 and 10% of diet, respectively) and decreased to a trace amount through fall and winter. Thickspike wheatgrass, bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandberg bluegrass were preferred foods in summer (Green and Flinders 1980b).

Weasels (*Mustela* spp.) are the principal predators of pygmy rabbits (Tesky 1994). The coyote (*Canis latrans*), red fox (*Vulpes vulpes*), badger, bobcat (*Felis rufus*), great horned owl (*Bubo virginianus*), and northern harrier (*Circus cyaneus*) also prey on pygmy rabbits (Bradfield 1975, Wilde and Keller 1978, Green and Flinders 1980a).

Some populations of pygmy rabbits are susceptible to rapid declines and possibly local extirpation. Some studies suggest that pygmy rabbits are a “high inertia” species with low capacity for rapid increase in density (Weiss and Verts 1984). The loss of habitat is probably the most significant factor contributing to pygmy rabbit population declines. Sagebrush cover is critical to pygmy rabbits and sagebrush eradication is detrimental (Holechek 1981). Protection of sagebrush, particularly on floodplains and where high water tables allow growth of tall, dense stands, is vital to the survival of pygmy rabbits (Flath 1994). Fragmentation of sagebrush communities also poses a threat to populations of pygmy rabbits (Weiss and Verts 1984) because dispersal potential is limited.

Therefore, fires that eliminate much of the big sagebrush have an adverse effect on pygmy rabbit populations. The loss of big sagebrush cover from pygmy rabbit home ranges reduces food availability and increases the rabbits’ vulnerability to predation. Pygmy rabbits are probably capable of escaping slow-moving fires, but they may be burned or die of asphyxiation in some fires. During a prescribed burn of a big sagebrush-grassland community in Idaho, several pygmy rabbits died in an area where the fire advanced rapidly (Tesky 1994). Although pygmy rabbits use burrows, the burrows evidently do not always provide them with effective protection from fire (Gates and Eng 1984). Furthermore, big sagebrush is often completely killed by fire and is slow to reestablish on burned sites. For instance, on the upper Snake River Plain in Idaho, big sagebrush did not recover to prefire densities until 30 years after an August fire (Harniss and Murray 1973), and some big sagebrush was eliminated from some areas due to repeated fire (Rosentreter and Jorgensen 1986).

2.4 Mule Deer (*Odocoileus hemionus*)



The mule deer is a popular game species in Idaho. Prior to the settlement of the West in the late 1800s and early 1900s, mule deer were not as abundant as they are currently (IDFG 1990). Intense grazing by domestic animals, as well as fire suppression, changed plant communities once dominated by grasses to ranges dominated by shrubs. This habitat change to shrub-dominated ranges in combination with reduced livestock grazing, reduced competition from other wild ungulates due to hunting, and regulated deer harvest promoted the growth of mule deer populations (IDFG 1990).

The mule deer mating season usually begins in mid-November and continues through mid-December (Snyder 1991). The gestation period lasts 203 days, with most young born between May and June (Lippincott 1997). Some July and August births also occur in some areas. Mature females commonly have twins, while yearlings have only single fawns. Weaning begins at about five weeks and is usually completed by the sixteenth week. Female mule deer usually breed at 2 years of age, while males may not mate until they are at least 3 or 4 years old due to competition with older males. The life span of a female mule deer can be as long as 22 years, while males may live as long as 16 years. Males begin to shed their antlers in December, though shedding can continue into March; mature and less healthy males might shed their antlers earlier.

Mule deer are most likely to be found in open forested regions or on the plains and prairies (Snyder 1991). In the mountainous regions of the West, they prefer rocky or broken terrain at elevations near or at the subalpine zone (Carpenter and Wallmo 1981). They are also found in alpine, montane, and foothill zones. Mule deer seek shelter at lower elevations when snows become deep. In the mountains of the Southwest, mule deer are found in lower-elevation shrublands, while white-tailed deer occupy the higher-elevation montane areas. In open prairie regions, mule deer tend to concentrate in river breaks and brushy stream bottoms (Mackie *et al.* 1987). In the high ranges of the Rocky Mountains, mule deer migrate during winter, sometimes moving 50 to 100 miles (80 to 160 km) (Mackie *et al*. 1987).

Mule deer are better adapted to open areas than white-tailed deer are, although cover becomes important in winter (Snyder 1991). Areas where cover can prevent snow from accumulating beyond 12 inches (30 cm) are most beneficial (Hanley 1984, Nyberg 1987). Wallmo and Schoen (1980) reported that mule deer could cope with snow up to 24 inches (60 cm) if not dense or crusty. Leckenby *et al*. (1982) and Black *et al.* (1976) listed optimal cover attributes for the Great Basin shrub-steppe region, including estimates of tree heights and canopy closure for thermal, hiding, fawning, and foraging cover. They estimated the proportions of cover and forage at 55% forage, 20% hiding cover, 10% thermal cover, 10% fawn-rearing cover, and 5% fawn habitat.

Mule deer are primarily browsers, feeding on several thousand different plant species across their range (Snyder 1991). They are capable of altering or severely damaging plant communities through overbrowsing (Reed 1981). Mule deer consume leaves, stems, and shoots of woody plants most often during summer and fall, while grasses and forbs compose the bulk of spring diets. However, feeding behavior is quite variable in any given location. Some of the most common foods are rabbitbrush (*Chrysothamnus* spp.), mountain mahogany (*Cercocarpus* spp.), snowberry (*Symphoricarpos* spp.), buffaloberry (*Shepherdia* spp.), ceanothus (*Ceanothus* spp.), rose (*Rosa* spp.), serviceberry (*Amelanchier* spp.), sagebrush (*Artemisia* spp.), sumac (*Rhus* spp.), common chokecherry (*Prunus virginiana*), willow (*Salix* spp.), Gambel oak (*Quercus gambellii*), mockorange (*Philadelphus lewisii*), ninebark (*Physocarpus* spp.), antelope bitterbrush (*Purshia tridentata*), mariposa (*Calochortus elegans*), juniper (*Juniperus* spp.), yucca (*Yucca* spp.), euphorbia (*Euphorbia* spp.), manzanita (*Arctostaphylos* spp.), lechuguilla (*Agave lechuguilla*), western yarrow (*Achillea millefolium*), red huckleberry (*Vaccinium parvifolium*), swordfern (*Polystichum munitum*), milkvetch (*Astragalus* spp.), and dandelion (*Taraxacum officinale*). Grasses include bluegrasses (*Poa* spp.), wheatgrasses (*Agropyron* spp.), and bromes (*Bromus* spp.) (Wallmo and Regelin 1981, Gruell 1986, Mackie *et al.* 1987, Happe *et al*. 1990).

Mule deer predators include people, domestic dogs (*Canis familiaris*), coyotes (*Canis latrans*), wolves (*Canis lupus*), black bears (*Ursus americanus*), grizzly bears (*U. arctos*), mountain lions (*Felis concolor*), lynx (*Lynx canadensis*), bobcats (*F. rufus*), and golden eagles (*Aquilla chrysaetos*) (Mackie *et al.* 1987).

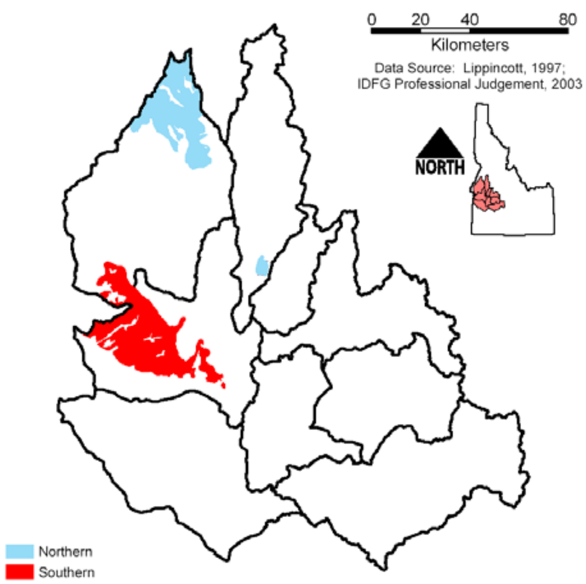
The effects of logging on mule deer populations vary between and within regions; therefore, it is difficult to generalize conclusions (Lyon and Jensen 1980). Site-specific studies are required to determine logging effects, although many studies confirm that slash depth is a major factor limiting mule deer use of harvested areas (Lyon and Jensen 1980, Hanley 1984). Studies in Alaska have shown that black-tailed deer avoid second growth forests after 20 to 30 years and instead turn to “over-mature” forests (older than 300 years) because these forests provide more browse than younger stands (Wallmo and Schoen 1980, Hanley 1984). Happe *et al*. (1990) have shown that, in coastal forests, forage in old growth has higher crude protein values than forage in clear-cuts. Tannin astringency of browse, which reduces digestive protein, is higher in clear-cuts than in old growth forests. Hanley (1984) recommended scattering clear-cuts in old growth in irregular shapes and spreading them over a wide elevational range.

A study in Colorado showed that, following a treatment in lodgepole pine-spruce-fir forests of alternating clear-cuts with uncut strips, mule deer increased after 10 years. Strips 100 feet (30 m) wide produced the best results (Wallmo 1969). Wallmo and Schoen (1980) listed management guidelines for timber harvesting that benefit deer in the western United States. However, they stated that some of these guidelines are based on speculation and all contradict claims that large clear-cuts are better for mule deer.

Mule deer are vulnerable to a variety of viral, fungal, and bacterial diseases (Hibler 1981). Epizootic hemorrhagic disease (EHD) resides in a small portion of the deer population and is spread from deer to deer by Culicoides gnats. The areas most affected include lower elevations along the Salmon River near White Bird and Riggins. Mule deer tend to inflict heavy crop damage, as well as damage to hayfields, stackyards, orchards, and reforestation projects (Snyder 1991). Mule deer are often attacked and killed by domestic dogs, and vehicles kill several hundred thousand deer each year (Reed 1981). Mule deer are not as tolerant of human activity and not as adaptable to disturbances as white-tailed deer are (Reed 1981).

2.5 Southern Idaho Ground Squirrel (*Spermophilus brunneus endemicus*)

The southern subspecies of the Idaho ground squirrel occurs at lower elevations (670–975 m) north of the Payette River in Gem, Payette, and Washington counties. Apparent extripation has occurred in area between extant populations of northern and southern subspecies.



The southern Idaho ground squirrel has a light gray-brown back with faint light spots and a cream-colored belly. The back of the legs, top of the nose, and underside of the base of the tail are rust colored. Ear pinnae project slightly above the crown of the head. (Note: this squirrel is larger in size and lighter in color than the northern Idaho ground squirrel.)

Relatively little was known about this species until quite recently, and much is yet to be learned about it. The southern populations emerge in late January to early February and cease aboveground activity in late June to early July; the northern populations are active aboveground from late March to early April until late July to early August. Activity is restricted by the time of snowmelt in spring and the desiccation (drying) of vegetation in mid to late summer.

Individuals dig burrows; entrances are often under rocks and logs. Burrows are extensive in shallow, rocky soils, but nest burrows are located in adjacent areas with deeper (greater than 1 m), well-drained soils. Indiscriminate shooting and poisoning are continued threats to the species, and because of the squirrel's small population and restricted range, the long-term future of its populations may be precarious.

The ground squirrel eats mainly grass seed and occasionally consumes roots, bulbs, and flower heads. It is dependent upon grasses that grow in open meadows and shrublands or grasslands that are bordered by coniferous forests. The species requires large quantities of food to store the body energy necessary for eight months of hibernation.

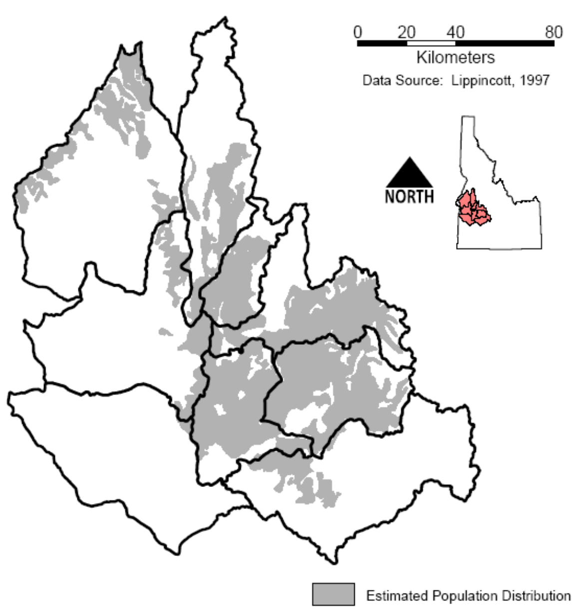
Ground squirrels provide a food base for a variety of predators. Birds of prey include the prairie falcon (*Falco mexicanus*), northern goshawk (*Accipiter gentilis*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*B. swainsoni*), ferruginous hawk (*B. regalis*), northern harrier (*Circus cyaneus*), Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), and raven (*Corvus corax*). Mammalian predators include the badger (*Taxidea taxus*), coyote (*Canis latrans*), and long-tailed weasel (*Mustela *frenata*). Reptilain predators include the gopher snake (*Pitouphis melanoleucus*) and western rattlesnake (*Crotalus viridus*).

The primary threat to the Idaho ground squirrel is habitat loss and fragmentation. When coniferous forests overtake suitable meadow habitats or when land is developed or converted to agriculture, squirrel habitat becomes disconnected. This fragmentation eliminates dispersal corridors and confines squirrel populations to small, isolated habitat areas.

The Idaho ground squirrel is also threatened by land use changes, fire suppression activities, recreational shooting, poisoning, genetic isolation and drift, construction and recreational development, and random natural disasters, as well as by competition from the larger Columbian ground squirrel.

3 Pine/Fir Forest (Dry, Mature)

3.1 White-headed Woodpecker (*Picoides albolarvatus*)



The white-headed woodpecker populations In Washington, Oregon, and Idaho have become more fragmented and reduced because of forestry practices (Marshall *et al*. 1992, Gilligan *et al*. 1994). It is listed as a protected nongame species in Idaho, and a Level I Partners in Flight priority species. A medium-sized woodpecker, it is about 21 to 23 cm long. It has a black body with a white head and white patches on its wings. The male woodpecker has a red spot on its nape. The plumage of juvenile woodpeckers is similar to that of adult woodpeckers, but the black is duller (Garrett *et al*. 1996).

The white-headed woodpecker lives in montane, coniferous forests from British Columbia to California and seems to prefer forest with a relatively open canopy (50–70% cover) and an availability of snags (partially collapsed, dead trees) and stumps for nesting. The birds prefer to build nests in trees of large diameter, with preference increasing with diameter. The understory vegetation within the preferred habitat is usually very sparse. Local populations are abundant in burned or cut forest where residual live and dead trees of large diameter are present.

White-headed woodpeckers are monogamous and may remain associated with their mate throughout the year (Robinson 1957). A pair builds its nest in an old tree, snag, or fallen log, always in dead wood. Every year, the pair constructs a new nest, a task that may take three to four weeks. The nests are, on average, 3 meters aboveground. The old nests are sometimes used for overnight roosting by the birds.

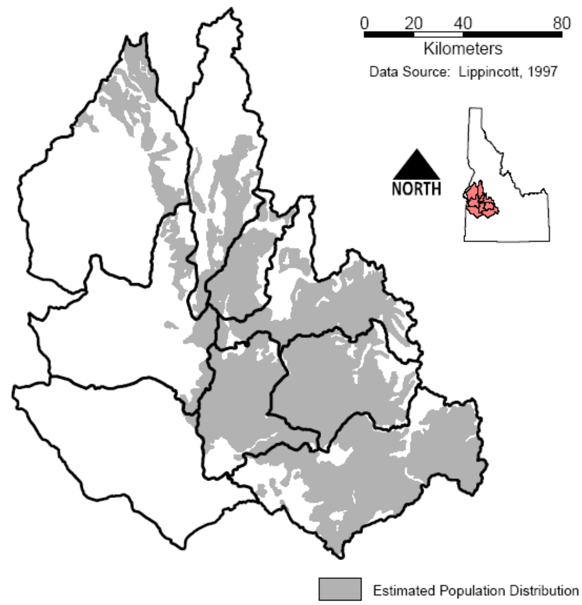
The breeding season is between May and July. The incubation period usually lasts for 14 days (Milne and Hejl 1989). The male roosts in the cavity with the young until they are fledged (Milne and Hejl 1989). The young leave the nest after about 26 days (Yom-Tov and Ar 1993). White-headed woodpeckers fledge about three to five young every year (Milne and Hejl 1989). They have one brood per breeding season, and there is no replacement brood if the first brood is lost.

The woodpeckers are not very territorial, except during the breeding season, and are essentially nonmigratory (Garrett *et al*. 1996). They are not especially social birds outside of family groups and pair bonds and generally do not have very dense populations (about one pair bond per 8 ha) (Garrett *et al*. 1996). The territory protected is not as large as this home range, however.

Unlike other members of its genus, the white-headed woodpecker appears to subsist largely on vegetable matter, with about 50 to 90% of the diet comprised of ponderosa pine seeds; the remainder is made up of ants, beetles, other insects, and spiders (Beal 1911, Ligon 1973). When foraging for insects on conifer trunks or branches, the woodpeckers flake and chip away bark with angled strokes, using the bill as a pry, rather than by drilling the wood directly (Ligon 1973). In summer, they feed by gleaning plant foliage in needle clusters, rather than by drilling and excavating.

There are a few threats to white-headed woodpeckers, such as predation and the destruction of their habitat. Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers (Garrett *et al*. 1996). Great horned owls are known to prey on adult white-headed woodpeckers. The major threat to this species, however, is the loss of its habitat and nesting sites (Cannings 1992). Logging removes the larger trees that the birds prefer to use for nesting. Fire suppression favors the replacement of pines by firs, and so the birds lose their source of food as well as their nesting sites (Raphael 1983). Population declines have been noted for white-headed woodpeckers in Idaho due to forest fragmentation and modification (Blair and Servheen 1993).

3.2 Flammulated Owl (*Otus flammeolus*)



The flammulated owl is the only small owl with dark blackish-brown eyes (all other small owls have a yellow iris), making it very distinctive. The owl is about 17 cm long and weighs between 45 and 63 g (McCallum 1994). The facial disk is pale gray with rusty brown around the eyes, boldest between the eye and white eyebrows, which start at the bill and wrap around into the forehead. The chest is light gray with deep-brown or black streaks, a splash of crossbarring, and dark mottling with intermittent rust. The back has darker grays and browns, mottled with grayish-horn to gray-brown. Although the sexes are alike in appearance, the male and female can be distinguished by call (the female has a higher-pitched whining call) (McCallum 1994).

The flammulated owl is also an insectivore and one of the most migratory owls in North America. It breeds in Idaho and then leaves the state to overwinter somewhere between central Mexico and Guatemala each year. Most owls migrate southward at the beginning of October and return to the breeding areas in late April or early May. The owl migrates primarily at night, and its migratory patterns are believed to be influenced by insect abundance (Balda *et al*. 1975).

Even though the flammulated owl has a lengthy migration, its breeding site fidelity is high, and nests are often used for multiple years. Most nest sites are in woodpecker holes or natural tree cavities, but nest boxes are also used (Bull and Anderson 1978, Smith 1981). The owl also seems to be somewhat colonial, congregating in breeding populations limited to one area, while adjacent areas of optimum habitat have no birds present (McCallum 1994). Egg laying occurs from about mid-April through the end of May. Generally, two to four eggs are laid. The female incubates them for 21 to 22 days, and the male feeds her during this time (Cannings and Cannings 1982, Goggans 1986). The young fledge at 21 to 25 days. For the first week afterward, they stay within about 100 meters of the nest and are fed by the adults (Linkhart and Reynolds 1987, McCallum 1994). During the second week, the young begin to learn to forage but are still supplemented by the adults (Richmond *et al*. 1980). The young become independent about 25 to 32 days after fledging (Linkhart and Reynolds 1987). Although the maximum age recorded for a wild owl is only about eight years, the life span is probably longer than this recorded age (Reynolds and Linkhart 1990).

The flammulated owl is generally associated with dry, montane forest habitats, often with thick brush understory or sapling thickets (McCallum 1994). Its favored areas are open aspen or ponderosa pine forest where the summers are dry and warm, the insect abundance or diversity is high, and nesting cavities are available (McCallum *et al*. 1994). The owl may also occur in forests with mixes of oak, Douglas-fir, white fir, incense cedar, or sugar pine. A major factor determining habitat selection may also be related to temperatures, with upper elevation limits set by low nocturnal temperatures and lower elevation limits set by high daytime temperatures (or humidity) (McCallum *et al*. 1994).

The diet of the flammulated owl includes nocturnal arthropods like owlet moths, beetles, crickets, grasshoppers, caterpillars, centipedes, millipedes, spiders, and scorpions (McCallum 1994). The owl's prey may be taken on the ground, among foliage, and often in the air (Reynolds and Linkhart 1987, 1992). A few records exist of flammulated owls consuming prey other than insects (i.e., small mammals, birds, or lizards), but these records are suspect as some are unsubstantiated or the birds were possibly misidentified (McCallum 1994).

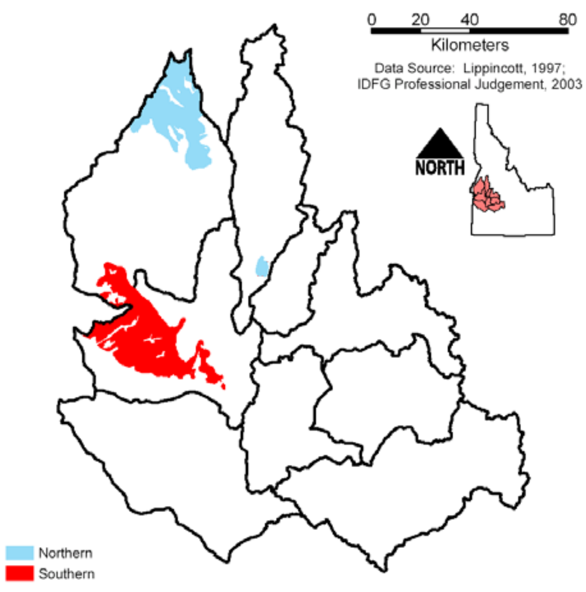
Predators such as red squirrels (*Tamiasciurus hudsonicus*), cats, and bears raid flammulated owl nests (Richmond *et al*. 1980). Adults are also subject to predation by the Cooper's hawk (*Accipiter cooperii*) and great horned owl (*Bubo virginianus*). To date, no diseases have been found in the flammulated owl population (McCallum 1994).

The flammulated owl is considered to be one of the most abundant owls of the western pine forests, and surveys in Idaho report densities of up to 1.25 males per 40 hectares (Moore and Frederick 1991). However, anthropogenic modifications of their preferred habitat in the past century may have caused undetected increases or decreases in numbers (McCallum and Gehlbach 1988). Changes in forest structure may also change insect abundance and, therefore, impact flammulated owl populations. Reynolds and Linkhart (1992) suggested that flammulated owls have higher individual fitness in old forest habitats.

3.3 Northern Idaho Ground Squirrel (*Spermophilus brunneus brunneus*)

The northern Idaho ground squirrel was listed as threatened on April 5, 2000 (66 FR 17779). This species is one of the rarest of North American ground squirrels, inhabiting about two dozen isolated demes in Valley and Adams counties; these demes occur at mid elevations (1,150–1,550 m).

The northern Idaho ground squirrel has a reddish-brown back with faint light spots and a cream-colored belly. The back of the legs, top of the nose, and underside of the base of the tail are reddish-brown. Ear pinnae project slightly above the crown of the head. (Note: this squirrel is smaller in size and rustier in color than the southern Idaho ground squirrel.)



The current population of northern Idaho ground squirrels is estimated at about 200 to 250 individuals. The squirrel is prone to extinction primarily because of habitat loss and fragmentation. Other factors impacting the squirrel's survival are competition with the Columbian ground squirrel (*Spermophilus columbianus*) and the recreational shooting of ground squirrels.

The Idaho ground squirrel is active for only a few months each year, emerging from underground hibernation in late March or early April. Within two weeks, a squirrel searches for a mate. It remains active until late July or early August and then returns to the winter burrow.

Female squirrels produce between 2 and 10 young. Female northern Idaho ground squirrels are known to live for up to eight years, while males die at a younger age due to behavior associated with reproductive activity.

The ground squirrel eats mainly grass seed and occasionally consumes roots, bulbs, and flower heads. It is dependent on grasses that grow in open meadows and shrublands or grasslands that are bordered by coniferous forests. The species requires large quantities of food to store the body energy necessary for eight months of hibernation.

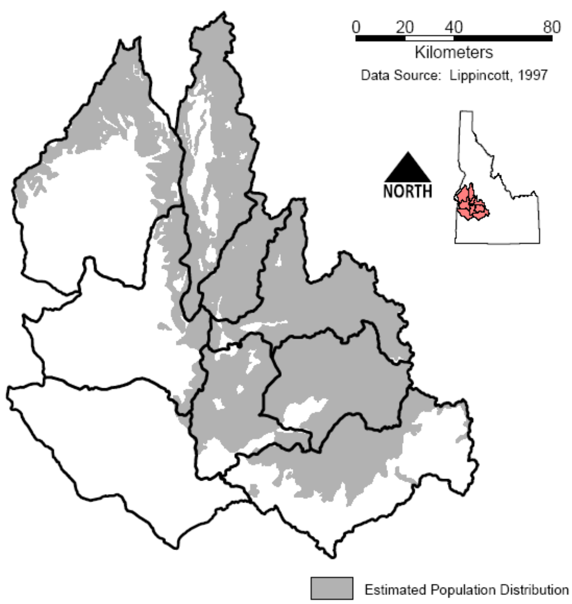
Ground squirrels provide a food base for a variety of predators. Birds of prey include the prairie falcon (*Falco mexicanus*) northern goshawk (*Accipiter gentilis*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*B. swainsoni*), ferruginous hawk (*B. regalis*), northern harrier (*Circus cyaneus*), Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), and raven (*Corvus corax*). Mammalian predators include the badger (*Taxidea taxus*), coyote (*Canis latrans*), and long-tailed weasel (*Mustela frenata*). Reptilain predators include the gopher snake (*Pitouphis melanoleucus*) and western rattlesnake (*Crotalus viridus*).

The primary threat to the northern Idaho ground squirrel is habitat loss and fragmentation. When coniferous forests overtake suitable meadow habitats or when land is developed or converted to agriculture, squirrel habitat becomes disconnected. This fragmentation eliminates dispersal corridors and confines squirrel populations to small, isolated habitat areas.

The northern Idaho ground squirrel is also threatened by land use changes, fire suppression activities, recreational shooting, poisoning, genetic isolation and drift, construction and recreational development, and random natural disasters, as well as by competition from the larger Columbian ground squirrel.

4 Interior Mixed Conifer

4.1 Pileated Woodpecker (*Dryocopus pileatus*)



The pileated woodpecker is the largest woodpecker found in Idaho and a permanent resident of deciduous or coniferous forest. The pileated woodpecker is best recognized by its large, dull-black body and brilliant-red crest. A white line extends from the bill across the cheek and down the neck. Because of its size and chisel-shaped bill (Short 1982), this woodpecker is particularly adept at excavating, and it uses this ability to construct nests and roost cavities and find food. The pileated woodpecker prefers to nest in mesic areas that are close to streams; it selects stands having the greatest basal area, greatest density of stems, and highest crown canopy.

Courtship begins in February to March, and a mated pair shares a territory all year. A clutch size of four is most common with this woodpecker. The incubation period is approximately 15 to 18 days (Kilham 1979, Harris 1982). The male and female alternately incubate the eggs during the day; the male incubates at night (Bull and Jackson 1995). Pileated woodpeckers breed after their first year and for each year thereafter (Bull and Meslow 1988). This woodpecker is known to live for at least nine years in the wild (Hoyt and Hoyt 1951, Hoyt 1952), but the life span is thought to be greater than this observed amount (Bull and Jackson 1995).

The pileated woodpecker feeds on insects, primarily carpenter ants and wood-boring beetle larvae; it also eats wild fruits and nuts (Hoyt 1957). It pries off long slivers of wood to expose ant galleries. The pileated woodpecker uses its long, extensible, pointed tongue with barbs and sticky saliva to catch and extract ants from tunnels (Hoyt 1950).

This woodpecker is adapted primarily for climbing on vertical surfaces, although it occasionally hops on the ground. It is awkward on small branches and vines when reaching for fruit. The bird is a strong flier, with slightly undulating strong flight; flight is rather slow but vigorous and direct (Sutton 1930, Short 1982). At night, the pileated woodpecker sleeps or roosts in a tree cavity, usually with multiple entrances (Bull *et al.* 1992). During conspecies conflict, there is much chasing, calling, striking with wings, and jabbing with bills (Bull and Jackson 1995). Drumming is used to proclaim a territory; it increases in frequency during early spring as courtship activities begin, and it is most frequent in the morning but can occur throughout the day (Mellen *et al*. 1992).

Known predators of the pileated woodpecker include the northern goshawk (*Accipiter gentilis*), Cooper's hawk (*A. cooperii*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), American marten (*Martes americana*), and gray fox (*Urocyon cinereoargenteus*) (Bull and Jackson 1995). Hawks primarily attack and chase pileated woodpeckers while in flight.

A large, nonmigratory insectivore, the pileated woodpecker may provide an important role in controlling insect outbreaks, particularly those of tree beetles. Also, this woodpecker may be a keystone species because its nest excavations provide habitat for many other species (Aubrey and Raley 2002). The pileated woodpecker hollows out nests 20 cm wide and up to 60 m deep.

Timber harvest has had the most significant impact on the pileated woodpecker's habitat. Forest fragmentation likely reduces population density and makes the birds more vulnerable to predation as they fly between forest fragments. Removal of large-diameter live and dead trees, downed woody material, and canopy closure eliminates nest and roost sites, foraging habitat, and cover (Bull and Jackson 1995).

Historically, different groups of Native Americans hunted these birds for a variety of reasons. Some tribes believed the red head crest was a talisman against all evil (Gabrielson and Jewett 1940), while other tribes used parts of the woodpecker for medicinal purposes (Bailey 1939). Some believed that possession of the woodpecker's head gave the owner the power to seek out and capture prey (Crabb 1930).

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APPENDIX 2-3—FOCAL HABITAT DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

Geographic Distribution—Riparian and wetland habitats dominated by woody plants are found throughout the Columbia Basin. Lowland willow and other riparian shrublands are the major riparian types throughout the Boise, Payette and Weiser subbasins at lower elevations. Common shrub associates include sandbar willow (*Salix exigua*), water birch (*Betula occidentalis*), yellow willow (*Salix lutea*), and Woods' rose (Hall and Hansen 1997, Jankovsky-Jones). Black cottonwood riparian habitats occur at low to middle elevations and develop best along large rivers, but these habitats are also present in narrow bands along small streams in the subalpine zone (Hall and Hansen 1997). Subdominant members of the overstory include narrowleaf cottonwood (*Populus angustifolia*), lanceleaf cottonwood (*P. acuminata*), and peachleaf willow (*Salix amygdaloides var. wrightii*).

White alder riparian habitats are restricted to perennial streams at low elevations; in drier climatic zones in Hells Canyon at the border of Oregon, Washington, and Idaho; in the Malheur River drainage; and in western Klickitat and south-central Yakima counties, Washington. Quaking aspen wetlands and riparian habitats are widespread but rarely a major component throughout the basin. Ponderosa pine-Douglas-fir riparian habitat occurs only around the periphery of the Columbia Basin in Washington and up into lower montane forests.

Physical Setting—Riparian habitats appear along perennial and intermittent rivers and streams. This habitat also appears in impounded wetlands and along lakes and ponds. Their associated streams flow along low to high gradients. The riparian and wetland forests are usually in fairly narrow bands along the moving water that follows a corridor along montane or valley streams. The most typical stand is limited to 100 to 200 ft (31-61 m) from streams. Riparian forests also appear on sites subject to temporary flooding during spring runoff. Irrigation of streamsides and toeslopes provides more water than precipitation and is important in the development of this habitat, particularly in drier climatic regions. Hydrogeomorphic surfaces along streams supporting this habitat have seasonally to temporarily flooded hydrologic regimes. Riparian and wetland habitats are found from 100 to 9,500 ft (31-2,896 m) in elevation.

Landscape Setting—Riparian habitats occur along streams, seeps, and lakes within the mixed conifer forest, ponderosa pine forest and woodlands, western juniper and mountain mahogany woodlands, and part of the shrub-steppe habitat. The riparian/herbaceous wetland habitat may be described as occupying warm montane and adjacent valley and plain riparian environments.

Structure—The riparian and wetland habitat contains shrublands, woodlands, and forest communities. Stands are closed to open canopies and often multilayered. A typical riparian habitat would be a mosaic of forest, woodland, and shrubland patches along a stream course. The tree layer can be dominated by broadleaf, conifer, or mixed canopies. Tall shrub layers, with and without trees, are deciduous and often nearly completely closed thickets. These woody riparian habitats have undergrowth of low shrubs or dense patches of grasses, sedges, or forbs. Tall shrub communities (20-98 ft [6-30 m], occasionally tall enough to be considered woodlands or forests) can be interspersed with sedge meadows or moist, forb-rich grasslands. Intermittently flooded riparian habitat has ground cover composed of steppe grasses and forbs. Rocks and boulders may be a prominent feature in this habitat.

Composition—Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), quaking aspen (*P. tremuloides*), white alder (*Alnus rhombifolia*), peachleaf willow (*Salix amygdaloides*) and, in northeast Washington, paper birch (*Betula papyrifera*) are dominant and characteristic tall deciduous trees. Water birch (*B. occidentalis*), shining willow (*Salix lucida* ssp. *caudata*) and, rarely, mountain alder (*Alnus incana*) are codominant to dominant, mid-size, deciduous trees. Each can be the sole dominant in stands. Conifers can occur in this habitat, rarely in abundance, more often as individual trees. The exceptions are ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), which characterize a conifer-riparian habitat in portions of the shrub-steppe zones.

A wide variety of shrubs are found in association with forest/woodland versions of this habitat. Redosier dogwood (*Cornus sericea*), mountain alder, gooseberry (*Ribes spp*.), rose (*Rosa spp*.), common snowberry (*Symphoricarpos albus*) and Drummond's willow (*Salix drummondii*) are important shrubs in this habitat. Bog birch (*B. nana*) and Douglas spiraea (*Spiraea douglasii*) can occur in wetter stands. Redosier dogwood and common snowberry are shade tolerant and dominate stand interiors, while these shrubs and others occur along forest or woodland edges and openings. Mountain alder is frequently a prominent shrub, especially at middle elevations. Tall shrubs (or small trees) often growing under or with white alder include chokecherry (*Prunus virginiana*), water birch, shining willow, and netleaf hackberry (*Celtis reticulata*).

Shrub-dominated communities contain most of the species associated with tree communities. Willow species (*Salix bebbiana, S. boothii, S. exigua, S geyeriana*, or *S. lemmonii*) dominate many sites. Mountain alder can be dominant and is at least co-dominant at many sites. Chokecherry, water birch, serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), and redosier dogwood can also be codominant to dominant. Shorter shrubs, such as Woods' rose, spiraea, snowberry and gooseberry are usually present in the undergrowth.

The herb layer is highly variable and is composed of an assortment of graminoids and broadleaf herbs. Native grasses (*Calamagrostis canadensis, Elymus glaucus, Glyceria spp., and Agrostis spp.*) and sedges (*Carex aquatilis*, *C. angustata*, *C. lanuginosa*, *C. lasiocarpa*, *C. nebrascensis*, *C. microptera*, and *C. utriculata*) are significant in many habitats. Kentucky bluegrass (*Poa pratensis*) can be abundant in areas that were heavily grazed in the past. Other weedy grasses, such as orchard grass (*Dactylis glomerata*), reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), bluegrass (*Poa bulbosa*, *P. compressa*), and tall fescue (*Festuca arundinacea*) often dominate disturbed areas. A short list of the great variety of forbs that grow in this habitat includes Columbian monkshood (*Aconitum columbianum*), alpine leafybract aster (*Aster foliaceus*), ladyfern (*Athyrium filix-femina*), field horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), skunkcabbage (*Lysichiton americanus*), arrowleaf groundsel (*Senecio triangularis*), stinging nettle (*Urtica dioica*), California false hellebore (*Veratrum californicum*), American speedwell (*Veronica americana*), and pioneer violet (*Viola glabella*).

Other Classifications and Key References—Cowardin *et al*. (1979) called this habitat Palustrine scrub-shrub and forest.

Other references that describe this habitat are Miller 1976; Manning and Padgett 1992; Kovalchik 1993; Christy and Titus 1996; and Crowe and Clausnitzer 1997. This habitat occurs in both lotic and lentic systems and is represented as riparian and wetland areas in the Idaho gap analysis (Scott *et al*. 2002), and as palustrine forest, palustrine shrubland, and palustrine emergent in the National Wetland Inventory (NWI).

Natural Disturbance Regime—This habitat is tightly associated with stream dynamics and hydrology. Flood cycles occur within 20 to 30 years in most riparian shrublands, although flood regimes vary among stream types. Fires recur typically every 25 to 50 years but fire can be nearly absent in colder regions or on topographically protected streams. Rafted ice and logs in freshets may cause considerable damage to tree boles in mountain habitats. Beavers crop younger cottonwood and willows and frequently dam side channels in these stands. These forests and woodlands require various flooding regimes and specific substrate conditions for reestablishment. Grazing and trampling is a major influence in altering structure, composition, and function of this habitat; some portions are very sensitive to heavy grazing.

Succession and Stand Dynamics—Riparian vegetation undergoes “typical” stand development that is strongly controlled by a site’s conditions following flooding and shifts in hydrology, or its “initial condition.” The initial condition of any hydrogeomorphic surface is a sum of the plants that survived the disturbance, the plants that can get to the site, and the amount of unoccupied habitat available for plant invasions. These factors select the species that can survive or grow at the site. Subsequent or repeated floods, or other influences on the initial condition, also affect that selection of species. A typical woody riparian habitat dynamic is the invasion of woody and herbaceous plants onto a new alluvial bar away from the main channel. If the bar is not scoured in 20 years, a tall shrub and small deciduous tree stand will develop. Approximately 30 years without disturbance or change in hydrology allows trees to overtop shrubs and form woodland. Another 50 years without disturbance allows conifers to invade, and in another 50 years, a mixed hardwood-conifer stand will develop. Conifers cannot invade many deciduous tall shrubs and trees. Each stage can be reinitiated, held in place, or shunted into different vegetation by changes in stream or wetland hydrology, fire, grazing, or an interaction of those factors.

Effects of Management and Anthropogenic Impacts—Management effects on woody riparian vegetation can be obvious (e.g., removal of vegetation by dam construction, roads, logging), or they can be subtle (e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat). In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use.

Status and Trends—Quigley and Arbelbide (1997) concluded that the cottonwood-willow cover type covers significantly less area now than before 1900 in the Inland Pacific Northwest. The authors concluded that, although riparian shrubland was a minor part of the landscape, occupying 2%, it had since declined to 0.5% of the landscape. Before 1900, approximately 40% of riparian shrublands occurred above 3,280 ft (1,000 m); now nearly 80% is found above that elevation. This change reflects losses to agricultural development, roads, and dams and other flood-control activities. The current riparian shrublands contain many exotic plant species and generally are less productive than they were historically. Quigley and Arbelbide (1997) found that riparian woodland was always rare and that the change in extent from the past is substantial.

2 Shrub-Steppe

Geographic Distribution—Shrub-steppe habitats are common across the Columbia Plateau of Washington, Oregon, Idaho, and adjacent Wyoming, Utah, and Nevada. It extends up into the cold, dry environments of surrounding mountains.

Basin big sagebrush shrub-steppe occurs along stream channels and in valley bottoms and flats throughout Idaho. Wyoming sagebrush shrub-steppe is the most widespread habitat, occurring throughout the Columbia Plateau and the northern Great Basin. Mountain big sagebrush shrub-steppe habitat occurs throughout the mountains of Idaho. Bitterbrush shrub-steppe habitat appears primarily in the southern portion of Idaho. Interior shrub dunes and sandy steppe and shrub-steppe habitat are concentrated at low elevations in isolated pockets in the Owyhee Uplands.

Physical Setting—Generally, this habitat is associated with dry, hot environments in the Pacific Northwest although variants are in cool, moist areas with some snow accumulation in climatically dry mountains. Elevation range is wide (300-9,000 ft [91-2,743 m]) with most habitat occurring between 2,000 and 6,000 ft (610-1,830 m). Habitat occurs on deep alluvial, loess, silty or sandy-silty soils; stony flats, ridges, or mountain slopes; and slopes of lakebeds with ash or pumice soils.

Landscape Setting—Shrub-steppe habitat defines a biogeographic region and is the major vegetation on average sites in the Columbia Plateau, usually below ponderosa pine forest and woodland and western juniper and mountain mahogany woodlands habitats. The shrub-steppe habitat forms mosaic landscapes with these woodland habitats and grasslands, dwarf shrub-steppe, and desert playa and salt scrub habitats. Mountain sagebrush shrub-steppe occasionally occurs at high elevations within the dry mixed conifer forest and montane mixed conifer forest habitats. Shrub-steppe habitat can appear in large landscape patches. Livestock grazing is the primary land use in the shrub-steppe, although much has been converted to irrigation or dry land agriculture. Large areas occur in military training areas and wildlife refuges.

Structure—This habitat is a shrub savanna or shrubland with shrub coverage of 10 to 60%. In an undisturbed condition, shrub cover varies between 10 and 30%. Shrubs are generally evergreen although deciduous shrubs are prominent in many habitats. Shrub height is typically medium-tall (1.6-3.3 ft [0.5-1.0 m]) although some sites support shrubs approaching 9 ft (2.7 m). Vegetation structure in this habitat is characteristically an open shrub layer over a moderately open to closed bunchgrass layer. The more northern or productive sites generally have a denser grass layer and sparser shrub layer than do southern or more xeric sites. In fact, the rare good-condition site is better characterized as grassland with shrubs than as shrubland. The bunchgrass layer may contain a variety of forbs. Good-condition habitat has very little exposed bare ground, with mosses and lichens carpeting the area between taller plants. However, heavily grazed sites have dense shrubs making up greater than40% cover, with introduced annual grasses and little or no moss or lichen cover. Moist sites may support tall bunchgrasses (>3.3 ft [1 m]) or rhizomatous grasses. More southern shrub-steppe may have native low shrubs dominating with bunchgrasses.

Composition—Characteristic and dominant mid-tall shrubs in the shrub-steppe habitat include all three subspecies of big sagebrush: basin (*Artemisia tridentata* ssp. *tridentata*), Wyoming (*A. tridentata* ssp. *wyomingensis*), or mountain *(A. tridentata* ssp. *vaseyana*); antelope bitterbrush (*Purshia tridentata*); and two shorter sagebrushes—silver (*A. cana*) and three-tip (*A. tripartita*). Each of these species can be the only shrub or can appear in complex seral conditions with other shrubs. Common shrub complexes are bitterbrush and Wyoming big sagebrush; bitterbrush and three-tip sagebrush; Wyoming big sagebrush and three-tip sagebrush; and mountain big sagebrush and silver sagebrush. Wyoming and mountain big sagebrush can codominate areas with tobacco brush (*Ceanothus velutinus*). Rabbitbrush (*Chrysothamnus viscidiflorus*) and short-spine horsebrush (*Tetradymia spinosa*) are common associates and often dominate sites after disturbance. Big sagebrush occurs with the shorter stiff sagebrush (*A. rigida*) or low sagebrush (*A. arbuscula*) on shallow soils or high elevation sites. Many sandy areas are shrub-free or are open to patchy shrublands of bitterbrush and/or rabbitbrush. Silver sagebrush is the dominant and characteristic shrub along the edges of stream courses, moist meadows, and ponds. Silver sagebrush and rabbitbrush are associates in disturbed areas.

When this habitat is in good ecological condition or better condition than it currently is, a bunchgrass steppe layer is characteristic. Diagnostic native bunchgrasses that often dominate different shrub-steppe habitats are 1) mid-grasses: bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), bottlebrush squirreltail (*Elymus elymoides*), and Thurber needlegrass (*Stipa thurberiana)*; 2) short grasses: threadleaf sedge (*Carex filifolia*) and Sandberg bluegrass (*Poa sandbergii*); and 3) the tall grass: basin wildrye (*Leymus cinereus*). Idaho fescue is characteristic of the most productive shrub-steppe vegetation. Bluebunch wheatgrass is codominant at xeric locations, whereas western needlegrass (*Stipa occidentalis*), long-stolon (*Carex inops*) sedge, or Geyer's sedge (*C. geyeri*) increase in abundance in higher elevation shrub-steppe habitats. Needle-and-thread (*Stipa comata*) is the characteristic native bunchgrass on stabilized, sandy soils. Indian ricegrass (*Achnatherum hymenoides*) characterizes dunes. Grass layers on montane sites contain slender wheatgrass (*Elymus trachycaulus*), mountain fescue (*F. brachyphylla*), green fescue (*F. viridula*), Geyer's sedge, or tall bluegrasses (*Poa spp*.). Bottlebrush squirreltail can be locally important in the Columbia Basin, sand dropseed (*Sporobolus cryptandrus*) is important in the Basin and Range and basin wildrye is common in the more alkaline areas. Nevada bluegrass (*Poa secunda*), Richardson muhly (*Muhlenbergia richardsonis*), or alkali grass (*Puccinella spp*.) can dominate silver sagebrush flats. Many sites support nonnative plants, primarily cheatgrass (*Bromus tectorum*) or crested wheatgrass (*Agropyron cristatum*), with or without native grasses. Shrub-steppe habitat, depending on site potential and disturbance history, can be rich in forbs or have little forb cover. Trees may be present in some shrub-steppe habitats, usually as isolated individuals from adjacent forest or woodland habitats. Additionally, shrub steppe in the Boise, Payette, and Weiser subbasins is host to Slickspot Peppergrass (*Lepidium papilliferum*), which is a rare vegetation inhabiting slick spots, or microplayas, in the region. Its occurrence is strongly localized, and it is a candidate species for federal protection, with State and Global Ranks of 2. Slickspot Peppergrass in this area is declining in population due to habitat fragmentation from wildfire and anthropogenic influence. Detailed discussion of slickspot peppergrass can be found in Appendix 1-3.

Other Classifications and Key References—Kuchler (1964) calls the shrub-steppe habitat Sagebrush steppe and Great Basin sagebrush. This habitat has also been called xeric shrublands (Scott *et al*. 2002). Other references describing this habitat include Winward 1970, Volland 1985, Winward 1980, Hironaka *et al*. 1983, Johnson and Simon 1987, and Johnson and Clausnitzer 1992.

Natural Disturbance Regime—Barrett *et al*. (1997) concluded that the fire-return interval for this habitat is 25 years. The native shrub-steppe habitat apparently lacked extensive herds of large grazing and browsing animals until the late 1800s. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Succession and Stand Dynamics—With disturbance, mature stands of big sagebrush are reinvaded through soil-stored or windborne seeds. Invasion can be slow because sagebrush is not disseminated over long distances. Site dominance by big sagebrush usually takes a decade or more depending on fire severity and season, seed rain, post-fire moisture, and plant competition. Three-tip sagebrush is a climax species that reestablishes (from seeds or commonly from sprouts) within 5 to 10 years following a disturbance. Certain disturbance regimes promote three-tip sagebrush, which can out-compete herbaceous species. Bitterbrush is a climax species that plays a seral role colonizing by seed onto rocky and/or pumice soils. Bitterbrush may be declining and may be replaced by woodlands in the absence of fire. Silver sagebrush is a climax species that establishes during early seral stages and coexists with later arriving species. Big sagebrush, rabbitbrush, and short-spine horsebrush invade and can form dense stands after fire or livestock grazing. Frequent or high-intensity fire can create a patchy shrub cover or can eliminate shrub cover and create grasslands habitat.

Effects of Management and Anthropogenic Impacts—Shrub density and annual cover increase with livestock use, whereas bunchgrass density decreases. Repeated or intense disturbance, particularly on drier sites, leads to cheatgrass dominance and replacement of native bunchgrasses. Dry and sandy soils are sensitive to grazing, with needle and thread replaced by cheatgrass at most sites. These disturbed sites can be converted to modified grasslands in the agriculture habitat.

Status and Trends—Shrub-steppe habitat still dominates most of southeastern Oregon although half of its original distribution in the Columbia Basin has been converted to agriculture. Alteration of fire regimes, fragmentation, livestock grazing, and the addition of more than 800 exotic plant species have changed the character of shrub-steppe habitat. Quigley and Arbelbide (1997) concluded that big sagebrush and mountain sagebrush cover types are significantly smaller in area than they were before 1900, and that bitterbrush/bluebunch wheatgrass cover type is similar to the pre-1900 extent. They concluded that basin big sagebrush and big sagebrush-warm potential vegetation types' successional pathways are altered, that some pathways of antelope bitterbrush are altered and that most pathways for big sagebrush-cool are unaltered. Overall, this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrub-steppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al*. 1998).

3 Pine/Fir Forest (Dry, Mature)

Forested lands in the subbasin are commonly distinguished by the types of trees they support, with differences in dominant tree species among sites generally reflecting geographic differences in temperature and moisture available for plant growth (Pfister *et al*. 1977, Arno 1979, Cooper *et al*. 1991). Due to the influence of moist maritime air flowing in from the Pacific Coast to the Continental Divide, the climate of the subbasin is generally mild for this region (Arno 1979). At a local scale, moisture levels tend to be high at middle elevations, on north-facing slopes, and in sheltered valleys (Barnes *et al*. 1998). In contrast, low, south-facing sites and high-elevation windy ridges are relatively dry. Lands at high elevations and shaded, north-facing slopes at lower elevations are generally cold, whereas sites at low elevations and on south-facing slopes are much warmer (Cilimburg and Short 2003).

Different tree species tend to thrive under different environmental conditions. For example, ponderosa pine thrives on sites that are relatively hot and dry during summer months (Foiles and Curtis 1973). In contrast, trees like western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) prosper in relatively mild and moist environments, like those found within the maritime-influenced climatic zones of northern Idaho and northwestern Montana (Pfister *et al.* 1977, Arno 1979, Cooper *et al.* 1991). Lodgepole pine (*Pinus contorta*) and subalpine fir (*Abies lasiocarpa*) are two tree species that grow relatively well in very cold locations within the region (Pfister *et al.* 1977, Cooper *et al*. 1991).

Such environmental affinities explain, in large part, the pattern of tree species distribution and forest development in the northern Rockies. They also help explain why forests dominated by different types of trees tend to have different fire histories. For example, the warm, dry environments in which the ponderosa pine thrives also happen to be extremely fire-prone, while the cold, moist environments that favor growth of the subalpine fir may seldom carry fire (Fischer and Bradley 1987, Smith and Fischer 1997). To emphasize the interconnectedness of environmental factors (moisture and temperature), tree species distribution, and fire, this discussion of fire in the northern Rockies in terms of four, broad forest types: dry montane forests, moist montane forests, lower subalpine forests, and upper subalpine forests. Each of these forest types experiences a unique moisture/temperature regime, roughly corresponding to (1) warm, dry; (2) warm, moist; (3) cool, moist; and (4) cold, moist environmental conditions.

For the purposes of this assessment, the discussion of pine/fir forests is in terms of ponderosa pine forest habitats, and the discussion of interior mixed conifer forests is in terms of montane mixed species forest habitats (see section 4.0).

Geographic Distribution—Ponderosa pine is the most widely distributed pine species in North America, ranging north-south from southern British Columbia to central Mexico and east-west from central Nebraska to the west coast (Little 1971). Ponderosa pine ecosystems occupy about 15.4 million hectares across 14 states (Garrison *et al*. 1977). Pacific ponderosa pine ranges from latitude 52 degrees N in the Fraser River drainage of southern British Columbia south through the mountains of Washington, Oregon, and California to latitude 33 degrees N near San Diego. In the northeastern part of its range, it extends east of the Continental Divide to longitude 110 degrees W in Montana and south to the

Snake River Plain in Idaho (Oliver and Russell 1990).

Physical Setting—This habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. Tree species that thrive on sites that are relatively warm and dry tend to dominate. These species include ponderosa pine, Douglas-fir, and western larch (*Larix occidentalis*). It is widespread and variable, appearing on moderate to steep slopes in canyons, foothills, and on plateaus or plains near mountains. In Idaho, this habitat can be maintained by the dry pumice soils. Average annual precipitation, often as snow, ranges from 14 to 30 in (36-76 cm) on ponderosa pine sites.

Both the mildest and coldest of these dry montane forests can support pure stands of Douglas-fir. On the warmest and driest sites, ponderosa pine tends to grow in pure stands. These stands become increasingly open with decreasing elevation or increasingly dry soils until they are so sparse that they are no longer considered forests. Ponderosa pine "woodlands," in which trees are so few and widely spaced that none of their crowns touch, are common at lower timberline and typically mark the transition from forest to grassland or shrubland. This transition generally occurs within 300 m of the valley base elevation (Arno 1979).

Landscape Setting—This woodland habitat typifies the lower tree-line zone forming transitions with mixed conifer forest and western juniper and mountain mahogany woodlands, shrub steppe, grassland, or agriculture habitats. Douglas-fir-ponderosa pine woodlands are found near or within the mixed conifer forest habitat. Ponderosa pine woodland is the vegetation type that Americans most commonly associate with western mountains (Peet 1988). However, the warm, dry conditions that naturally favor development and persistence of these open, park-like stands are characteristic of only a small fraction of the forested area within the northern Rockies. Douglas-fir often predominates at lower elevations, where valley base elevations are high and winter temperatures are too low for ponderosa pine. Western larch, the only deciduous conifer in the region, is an often-conspicuous component of low-elevation forests.

Structure—This habitat is typically a woodland or savanna with tree canopy coverage of 10 to 60%, although closed-canopy stands are possible. The tree layer is usually composed of widely spaced, large conifer trees. Many stands tend toward a multilayered condition with encroaching conifer regeneration. Isolated, taller conifers above broadleaf deciduous trees characterize part of this habitat. Deciduous woodlands or forests are an important part of the structural variety of this habitat. Clonal deciduous trees can create dense patches across a grassy landscape rather than scattered individual trees. The undergrowth may include dense stands of shrubs or, more often, be dominated by grasses, sedges, or forbs. Shrub steppe shrubs may be prominent in some stands and create a distinct tree-shrub-sparse-grassland habitat.

Composition—Ponderosa pine (Pinus ponderosa) and Douglas-fir are the most common evergreen trees in this habitat. The deciduous conifer western larch (Larix occidentalis) can be a co-dominant with the evergreen conifers, but seldom as a canopy dominant. Grand fir (*Abies grandis*) may be frequent in the undergrowth on more productive sites, giving stands a multilayer structure. In rare instances, grand fir can be codominant in the upper canopy.

The understories of xeric, old forests are usually sparse due to the lack of moisture. Common native grasses and grass-like plants include Idaho fescue, rough fescue, bluebunch wheatgrass, pinegrass (*Calamagrostis rubescens*), and elk sedge (*Carex garberi*). Forbs include arrowleaf balsamroot (*Balsamorhiza sagittata*), lupines (*Lupinus* spp.), heartleaf arnica (*Arnica cordifolia*), mountain sweetroot (*Osmorhiza chilensis*), and western meadow rue (*Thalictrum occidentale*). Common snowberry, mountain snowberry (*Symphoricarpos oreophilus*), antelope bitterbrush (Purshia tridentate), bearberry *(Arctostaphylos Uva-Ursi, Sprengel),* white spirea (*Spiraea betulifolia*), Oregon grape (*Mahonia aquifolium*, formerly *Berberis aquifolium*), Saskatoon serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus* spp.), russet buffaloberry (*Shepherdia canadensis*), common juniper (*Juniperus communis*), and chokecherry are important woody species (Pfister *et al*. 1977, Cooper *et al*. 1991).

Other Classifications and Key References—The Society of American Foresters refers to this habitat as Pacific ponderosa pine-Douglas-fir. This habitat is also called Needleleaf Forest-Ponderosa Pine (Scott *et al*. 2002). Other references describing elements of this habitat include Johnson and Clausnitzer 1992; Lillybridge *et al.* 1995; and Volland 1985.

Natural Disturbance Regime—Fire plays an important role in creating vegetation structure and composition in this habitat. Most of the habitat has experienced frequent low-severity fires that maintained woodland or savanna conditions. A mean fire interval of 20 years for ponderosa pine is the shortest of the vegetation types listed by Barrett *et al*. 1997. Soil drought plays a role in maintaining an open tree canopy in part of this dry woodland habitat.

Succession and Stand Dynamics—This habitat is climax on sites near the dry limits of each of the dominant conifer species and is more seral as the environment becomes more favorable for tree growth. Open seral stands are gradually replaced by more closed shade-tolerant climax stands.

Anthropogenic Impacts—Before 1900, this habitat was mostly open and park like with relatively few undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species, giving the habitat a more closed, multilayered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Fire suppression has lead to a buildup of fuels that in turn increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support invasion by conifers. Large late seral ponderosa pine and Douglas-fir are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. In some areas, patchy tree establishment at the forest-steppe boundary has created new woodlands.

Status and Trends—Quigley and Arbelbide (1997) concluded that the Interior Ponderosa Pine cover type is significantly less in extent than before 1900. They included much of this habitat in their dry forest potential vegetation group 181, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One third of ponderosa pine, and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al*. 1998).

4 Interior Mixed Conifer–Montane Mixed Species Forest

Geographic Distribution—The mid-elevation forests of the northern Rockies are relatively moist, receiving at least 20 in (50 cm) of mean annual precipitation. The wetter conditions allow drought-tolerant tree species such as ponderosa pine, Douglas-fir, western larch, western white pine (*Pinus monticola*), and lodgepole pine to grow alongside less drought-tolerant species like grand fir, western red cedar, western hemlock, Engelmann spruce (*Picea engelmannii*), and subalpine fir. These species co-occur in various combinations at elevations between 2,999 and 6,998 ft (914–2,133 m) throughout Idaho. These assemblages are generally referred to as "mixed conifer" forests. The mixed conifer forest habitat appears primarily in the Blue Mountains, East Cascades, and Okanogan Highland ecoregions of Oregon, Washington, adjacent Idaho, and western Montana. It also extends north into British Columbia (IBIS 2003)

Physical Setting—This habitat receives some of the greatest amounts of precipitation in the inland northwest, 30 to 80 in (76–203 cm) per year. Elevation of this habitat varies geographically, with generally higher elevations to the east. Douglas-fir is common throughout the entire spectrum of these forests but is most abundant on sites receiving 20 to 25 inches (50–63 cm) of rain per year—the driest of the mesic montane forests. Some of these relatively warm, dry stands may also support ponderosa pine and appear similar to low-elevation, dry forests. Grand fir is also common at low to middle elevations, but typically predominates on sites receiving more than 25 inches (63 cm) of precipitation per year (Arno 1980, Peet 1988).

On even wetter (greater than 32 in [81 cm] of annual rainfall) yet still relatively warm sites, luxuriant forests of western red cedar and western hemlock can be found. These highly productive forests, which can contain representatives of the other eight tree species listed above, tend to occur at moderately low elevations (below 4,290 ft [1,500 meters]) within the balmy, maritime-influenced climatic zone of the northern Rocky Mountains (Arno 1979, Cooper *et al*. 1991). This zone generally extends from northern Idaho eastward in Montana to Glacier National Park and to the Swan, Clearwater, lower Blackfoot, and Bitterroot river valleys (Arno 1979).

On cooler sites, mixtures of western larch, lodgepole pine, subalpine fir, and Engelmann spruce are common.

Landscape Setting—This habitat makes up most of the continuous montane forests of the inland Pacific Northwest. It is located between the subalpine portions of the montane mixed conifer forest habitat and lower tree line ponderosa pine forests.

Structure—Stand canopy structure is generally diverse, although single-layer forest canopies are currently more common than multilayered forests with snags and large woody debris. The tree layer varies from closed forests to more open-canopy forests or woodlands. This habitat may include very open stands. The undergrowth is complex and diverse. Tall shrubs, low shrubs, forbs or any combination may dominate stands. Deciduous shrubs typify shrub layers. Prolonged canopy closure may lead to development of sparsely vegetated undergrowth.

Composition—This habitat contains a wide array of tree species (9) and stand dominance patterns. Douglas-fir is the most common tree species in this habitat. It is almost always present and dominates or co-dominates most overstories. Lower elevations or drier sites may have ponderosa pine as a co-dominant with Douglas-fir in the overstory and often have other shade-tolerant tree species growing in the undergrowth. On moist sites, grand fir, western red cedar and/or western hemlock are dominant or co-dominant with Douglas-fir. Other conifers include western larch and western white pine on mesic sites, Engelmann spruce, lodgepole pine, and subalpine fir on colder sites. Spruce-dominated forests can be found on benches and gentle north slopes, and the cedar-hemlock forest type is most common along moist canyon bottom sites or seepages (Cilimburg and Short 2002).

The often luxuriant understories of moist montane forests tend to consist of diverse mixtures of shrubs and moist-site forbs. Common woody species include ninebark, common snowberry, white spirea, oceanspray (*Holodiscus discolor*), blue huckleberry (*Vaccinium membranaceum*, grouse whortleberry (*Vaccinium scoparium*), bearberry, twinflower (*Linnaea borealis*), Sitka alder (*Alnus viridis* ssp. *sinuata*), redosier dogwood, Utah honeysuckle (*Lonicera utahensis*), menziesia, thimbleberry (*Rubus parviflorus*), common juniper, bunchberry (*Cornus Spp*.), bristly black currant (*Ribes lacustre*), russet buffaloberry, Saskatoon serviceberry, and devilsclub (*Oplopanax horridus*). Forbs include starry Solomon's seal, rough-coated fairy bells (*Disporum Spp*.), western meadow-rue, broadleaf arnica, heartleaf arnica (*Arnica latifolia*), mountain arnica (*A. montana*), red baneberry (*Actaea rubra*), queencup beadlily, sweetscented bedstraw (*Galium odoratum*), Richardson's geranium, arrowleaf groundsel (*Senecio triangularis*), wild ginger (*Asarum canadense)*, twistedstalk (Streptopus Spp.), darkwoods violet (*Viola orbiculata*), wild sarsaparilla (*Aralia nudicaulis*), and western rattlesnake plantain (*Goodyera oblongifolia*). Other understory associates include bluejoint reedgrass (*Calamagrostis Canadensis)*, pinegrass, Columbia brome (*Bromus vulgaris*), field horsetail, oakfern *Gymnocarpium newman*), ladyfern (*Athyrium filix-femina*), common beargrass (*Xerophyllum tenax*), and elk sedge.

Other Classifications and Key References—This habitat includes the moist portions of the Douglas-fir, grand fir, and western hemlock zones of eastern Oregon and Washington (American Forest 1998). Kuchler (1964) calls this habitat Douglas-fir (Associated Press 1991), cedar-hemlock-pine (Atzet *et al*. 1990), and grand fir-Douglas-fir (Atzet and Wheeler 1982) forests. Scott *et al*. (2002) classified this habitat as needleleaf forest-mixed xeric forest. Cover types that would represent this type are the Douglas-fir-dominant mixed-conifer forests and ponderosa pine-dominant mixed-conifer forest. Other references detailing forest associations for this habitat include Daniels 1969; Hopkins 1979a,b; Volland 1985; Johnson and Simon 1987; Marsh *et al.* 1987; Topik *et al*. 1988; Topik 1989; Johnson and Clausnitzer 1992; Zack and Morgan 1994; Lillybridge *et al*. 1995; and Williams *et al*. 1995.

Natural Disturbance Regime—Fires were probably of moderate frequency (30–100 years) in presettlement times. Inland Pacific Northwest Douglas-fir and western larch forests have a mean fire interval of 52 years (Barrett *et al*. 1997). Typically, stand-replacement fire-return intervals are 150 to 500 years with moderate severity-fire intervals of 50 to 100 years. Specific fire influences vary with site characteristics. Generally, wetter sites burn less frequently than drier sites, and stands are older, with more western hemlock and western red cedar than in drier sites. Many sites dominated by Douglas-fir and ponderosa pine, which were formerly maintained by wildfire, may now be dominated by grand fir (a fire sensitive, shade-tolerant species).

Succession and Stand Dynamics— Successional relationships of this type reflect complex interrelationships among site potential, plant species characteristics, and disturbance regime (Zack and Morgan 1994). Generally, early seral forests of shade-intolerant trees (western larch, western white pine, ponderosa pine, Douglas-fir) or shade-tolerant trees (grand fir, western red cedar, western hemlock) develop some 50 years following disturbance. Forb- or shrub-dominated communities precede this stage. These early stage mosaics are maintained on ridges and drier topographic positions by frequent fires. Early seral forest develops into mid-seral habitat of large trees during the next 50 to 100 years. Stand-replacing fires recycle this stage back to early seral stages over most of the landscape. Without high-severity fires, a late seral condition develops either single-layer or multilayer structure during the next 100 to 200 years. These structures are typical of cool bottomlands that usually experience only low-intensity fires.

Effects of Management and Anthropogenic Impacts—This habitat has been most affected by timber harvesting and fire suppression. Timber harvesting has focused on large shade-intolerant species in mid- and late seral forests, leaving shade-tolerant species. Fire suppression enforces those logging priorities by promoting less fire-resistant, shade-intolerant trees. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than it was in historical, native systems (Quinn 1997). Late seral forests of shade-intolerant species are now essentially absent. Early seral forest abundance is similar to that found historically, but lacks snags and other legacy features.

Status and Trends—Quigley and Arbelbide (1997) concluded that the interior Douglas-fir, grand fir, and western red cedar/western hemlock cover types are more abundant now than before 1900, whereas the western larch and western white pine types are significantly less abundant. Twenty percent of Pacific Northwest Douglas-fir, grand fir, western red cedar, western hemlock, and western white pine associations listed in the National Vegetation Classification are considered imperiled or critically imperiled. (Anderson *et al*. 1998). Roads, timber harvest, periodic grazing, and altered fire regimes have compromised these forests. Even though this habitat is more extensive than it was before 1900, natural processes and functions have been modified enough to alter its natural status as functional habitat for many species.

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