Aquatic/Riparian/Hydrologic Component

Key Terms Used in This Section

Anadromous fish — Fish that hatch in freshwater, migrate to the ocean, where they mature in salt water, and return to freshwater to reproduce; for example, salmon and steelhead.

Beneficial Uses —Various uses for water including, but not limited to: domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, fish and wildlife habitat, and aesthetics. The beneficial use depends on actual use, the ability of water to support a non-existing use either now or in the future, and its likelihood of being used in a given manner. The use of water for wastewater dilution or as receiving water for waste treatment facility effluent are not considered beneficial uses.

Best Management Practices — Practices designed to prevent or reduce water pollution.

Biotic Integrity —The ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region.

Endemic Species — Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality.

Extinction — Complete disappearance of a species from the earth.

Extirpation — Loss of populations from all orpart of a species' range within a specified area.

Headwaters — Beginning of a watershed; unbranched tributaries of a stream.

Hybridization —The cross-breeding of unlike individuals to produce hyploid offspring.

Hydrologic — Refers to the properties, distribution, and effects of water. "Hydrology" refers to the broad science of the waters of the earth—their occurrence, circulation, distribution, chemical and physical properties, and their reaction with the environment.

Large Woody Debris — Pieces of wood that are of a large enough size to affect stream channel morphology.

Pools — Portions of a stream where the current is slow, often with deeper water than surrounding areas and with a smooth surface texture. Pools often occur above and below riffles and generally are formed around stream bends or obstructions such as logs, root wads, or boulders. Pools provide important feeding and resting areas for fish.

Refugia — Areas that have not been exposed to significant environmental changes or disturbances undergone by the region as a whole. Refugia provide conditions suitable for survival of species that may be declining elsewhere.

Resident Fish — Fish that spend their entire life in freshwater; examples include bull trout and westslope cutthroat trout.

Riparian areas —Area with distinctive soil and vegetation between a stream or other body of water and the adjacent upland; includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Salmonid — Fishes of the family Salmonidae, including salmon, trout, chars, whitefish, ciscoes, and grayling.

Sediment — Solid materials, both mineral and organic, in suspension or transported by water, gravity, ice, or air; may be moved and deposited away from their original position and eventually will settle to the bottom.

Sensitive species — Species identified by a Forest Service regional forester or BLM state director for which population viability is a concern either (a) because of significant current or predicted downward trends in population numbers or density, or (b) because of significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Seral — Refers to the stages that plant communities go through during succession. Developmental stages have characteristic structure and plant species composition. In a forest, for example, early seral forest refers to seedling or sapling growth stages; mid seral forest refers to pole or medium saw timber growth stages; and mature or late seral forest refers to mature and old-growth stages.

Strongholds/Strong populations (fish) — Subwatersheds that have the following characteristics: (1) presence of all major life-history forms (for example, resident, fluvial, and adfluvial) that historically occurred within the subwatershed; (2) numbers of fish are stable or increasing, and the local population is likely to be at half or more of its historical size or density; (3) the population or metapopulation of fish within the subwatershed, or within a larger region of which the watershed is a part, probably contains at least 5,000 individuals or 500 adults.

Subbasin — A drainage area of approximately 800,000 to 1,000,000 acres, also called a 4th-field Hydrologic Unit Code (HUC).

Subwatershed — A drainage area of approximately 20,000 acres, also called a 6th-field Hydrologic Unit Code (HUC). Hierarchically, a subwatershed is contained within a watershed, which in turn is contained within a subbasin.

Uplands — The portion of the landscape above the valley floor or stream.

Watershed — 1) The region draining into a river, river system, or body of water. 2) In this EIS, the term watershed also refers specifically to a drainage area of approximately 50,000 to 100,000 acres, which is also called a 5th-field Hydrologic Unit Code (HUC).

Wetlands — In general, an area soaked by surface or groundwater frequently enough to support vegetation that requires saturated soil conditions for growth and reproduction; generally includes swamps, marshes, bogs, wet meadows, mudflats, natural ponds, and other similar areas. For legal definition, see Glossary.

Summary of Conditions and Trends

Aquatic and Riparian Habitats

- Streams and rivers are highly variable across the project area, reflecting diverse physical settings and disturbance histories. Nevertheless, important aspects of stream channel stability, such as channel complexity and large wood abundance, have decreased throughout much of the project area. Aquatic species habitat features such as riffle-pool frequency and wood frequency are generally less in areas with higher road densities and in areas where timber harvest has been a management emphasis.
- The overall extent and continuity of riparian areas and wetlands has decreased, primarily because of conversion to agriculture but also because of urbanization, transportation improvements, and stream channel modifications.
- Riparian ecosystem function, determined by the amount and type of vegetation cover, has decreased in most subbasins within the project area. However, the rate has slowed, and a few areas show increases in riparian cover and large trees.
- Most riparian areas on Forest Service- or BLM-administered lands are either “not meeting objectives”, “non-functioning”, or “functioning at risk.”
- Within riparian woodlands, the abundance of mid seral vegetation has increased, whereas the abundance of late and early seral structural stages has decreased, primarily because of fire exclusion and harvest of large trees.
- Within riparian shrublands, there has been extensive conversion to riparian herblands and increases in exotic grasses and forbs, both primarily because of processes and activities associated with excessive livestock grazing pressure. Finer scale information also indicates an extensive spread of western juniper into riparian shrublands.
- There is an overall decrease in large trees and late seral vegetation in many riparian areas.
- The frequency and extent of seasonal flooding necessary to maintain riparian and wetland function have been altered by changes in flow regime due to dams, diversions, and groundwater withdrawal, and by changes in channel geometry due to sedimentation and erosion, channelization, and installation of transportation improvements such as roads and railroads.

Water Quality

- Management activities throughout the project area have affected water quality, which is important to aquatic habitats and riparian and wetland areas by altering the streamflow, erosion, and sedimentation regimes, and the production and distribution of organic material. On federally administered lands the most pronounced changes to water quality are due to road construction, vegetation alteration (including silvicultural practices, fire exclusion, and forage production), improper livestock grazing, and water diversions and impoundments.
- Water quantity effects on water quality have been locally affected by dams, diversions, and groundwater withdrawal. More subtle but widespread changes in water quantity on federally administered lands have probably been caused by road construction and changes in vegetation due to silvicultural practices and excessive livestock grazing pressure.
- Within the project area, approximately eight percent of stream miles on Forest Service- or BLM-administered lands are water quality limited as defined by the Clean Water Act. On Forest Service-administered lands, the primary water quality problems are non-point sources of pollution consisting of sedimentation, turbidity, flow alteration, and high temperatures. On BLM-administered lands, water quality limited segments are listed because of non-point pollution sources consisting of high sediment, turbidity, and high temperatures.

Aquatic Species

- The composition, distribution, and status of fishes within the project area are different than they were historically. Some native fishes have been extirpated from large portions of their historical ranges.
- Many native nongame fish are vulnerable because of their restricted distribution or fragile or unique habitats.
- Although several of the key salmonids are still broadly distributed (notably the cutthroat trout and redband trout), declines in abundance, loss of life history patterns, local extinctions, and fragmentation and isolation in smaller blocks of high quality habitat are apparent.
- Wild chinook salmon and steelhead are near extinction in a major part of their remaining

distribution, largely because of the construction and operation of mainstem dams on the Columbia and Snake rivers.

- Habitat, hydropower, harvest, hatchery management, and irrigation withdrawals all affect the survival of remaining anadromous fish populations within the interior Columbia River Basin to different extents. Land management activities have affected habitat for wild chinook and steelhead and have limited their spawning and rearing success. The contribution of freshwater habitat to declines in anadromous fish populations would be greatest in the lower Snake and mid-Columbia drainages, and least in the northern Cascades and in central Idaho (for example in wilderness areas and other protected areas), which is affected by the most dams between spawning and rearing areas and the ocean. The influence of hydropower on anadromous fish populations increases upriver, where there are more dams between freshwater spawning and rearing areas and the ocean. Harvest, which has been curtailed in recent years, has less effect on anadromous fish today than it did historically. Hatcheries are an important element throughout the basin, but their effect on native stocks is variable.
- Core areas for rebuilding and maintaining biological diversity associated with native fishes still exist within the project area.

Aquatic/Riparian Health— A Definition

Healthy aquatic and riparian habitats support animal and plant communities that can adapt to environmental changes and follow natural evolutionary and biogeographic processes. Healthy aquatic and riparian systems are resilient and recover rapidly from natural and human disturbance. They are stable and sustainable, in that they maintain their organization and autonomy over time and are resilient to stress, in part because of their high biological diversity and habitat complexity. In a healthy aquatic/riparian system there is a high degree of connectivity from headwaters to downstream reaches, from streams to floodplains, and from subsurface to surface flows. Floods can spread into floodplains, and fish and wildlife populations can move freely throughout the watershed. Healthy aquatic and riparian ecosystems also maintain long-term soil productivity. Rates of erosion vary, but overall soil and nutrient loss do not exceed soil formation rates. There is sufficient vegetation, leaf litter, and large woody debris to allow percolation of rainwater into soils and groundwater without excessive runoff or accelerated rates of erosion. Mineral and energy cycles continue without loss of efficiency.

Healthy watersheds provide numerous ecosystem services to people. These include: (1) high quality and dependable water supplies; (2) moderation of the effects of flooding, drought, and climate change; (3) recharge of stream systems and groundwater aquifers; (4) maintenance of diverse and productive riparian plant communities that trap silt and buffer the high energy of floods; and (5) maintenance of healthy riparian areas that moderate stream temperature by shade and buffer sediment pulses from adjacent hillslopes. The diversity of native fish populations increases in response to ecosystem recovery if recolonization sources are available.

— Adapted from Williams, Wood, and Dombeck 1997

Introduction

This section summarizes the condition of aquatic ecosystems by first characterizing the aquatic habitats, riparian and wetland areas, and water quality of the project area. This is followed by a description of the status of fish species that use and are affected by these environments, focusing on past and current conditions of many fish species in the entire project area. Special attention is given to native fish species, especially wide-ranging salmon and trout species. Aspects of native fishes that are particularly affected by regional-scale management decisions are emphasized. Issues discussed include: (1) current conditions of native, threatened or endangered, and introduced species; (2) condition, status, and trends of key salmonids; (3) biotic and genetic integrity; and (4) subbasin categories.

Hydrologic environments and their key processes and conditions (such as streamflow, sedimentation, erosion, and channel formation) are described earlier in this chapter in the Physical Setting section. Water quality is a key indicator resulting from the physical environment that influences or modifies the physical and biological characteristics of riparian and aquatic ecosystems, and is discussed in this section.

Information in this section is drawn from Hann, Jones, Karl, et al. (1997); Lee et al. (1997); Henjum et al. (1994); Wissmar et al. (1994); and other sources as cited.

Aquatic Habitats

Many aquatic and riparian plant and animal species in the project area have evolved in concert with the dynamic nature of stream channels, developing traits, life-history adaptations, and propagation strategies that allow persistence and success within landscapes that experience harsh disturbance regimes. Figure 2-17, later in this chapter, illustrates how salmon and trout use various portions of a stream during different parts of their life cycles. See the Physical Setting section, earlier in this chapter, for more detailed discussion of stream channel processes, functions, and patterns.

Lee et al. (1997) addresses the current status of stream channel morphology in the project area in relation to management actions through analysis of aquatic habitat inventories. These analyses include resurveys of 120 streams inventoried in the 1930s and 1940s, and more than 6,000 stream inventories completed in the past five years that summarize stream conditions across a spectrum of physiographic environments and management histories. Key findings from analysis of both data sets indicate that stream channel morphology is highly variable, depending on stream type and biophysical environment, but there are major correlations between management intensity and stream channel morphology over time and space.

Aspects of channel morphology in the project area that have apparently been affected by land management practices include the frequency of pools, the frequency of large pieces of wood in the channel, and the composition of substrate (amount of fine sediment). Low gradient (slopes less than two percent) and larger streams are apparently the most sensitive to high road densities and where there is emphasis on timber harvest. Pool frequency and wood frequency are generally less in areas with more management activities. Additionally, where measured, the percent of the channel bed covered with fine sediment (less than 0.25 inches) increases with road density. These findings are consistent with observations from site-specific analyses that indicate that improper road construction, excessive livestock grazing pressure, and timber harvest practices increase delivery of fine sediment to stream channels, filling pools and causing stream aggradation (Furniss et al. 1991; Hicks et al. 1991). For a description of channel morphology across the project area, see Jensen et al. (1997) and Lee et al. (1997) in the *Assessment of Ecosystem Components* (Quigley and Arbelbide 1997).

In addition to changes to streams and rivers such as those discussed in the *Scientific Assessment*, land management practices have caused an overall change in the scale and frequency of landscape disturbance, resulting in a distinctly different character of watersheds and their stream systems when viewed from a regional perspective. Individual and isolated watersheds, riparian areas, and stream channels used to be affected from time to time by large disturbances such as floods, fire, and insect infestations, but other neighboring watersheds remained largely unaffected. Most streams and associated species in the project area evolved with this pulse-like pattern of disturbance. However, past land management practices have led to increased levels of watershed disturbances

Most stream channels are in a somewhat 'unnatural' condition, with habitat conditions that are less than optimal for aquatic and riparian-dependent species.

spread over time and space. Consequently, most watersheds contain stream channels and aquatic habitats that are now subject to cumulative effects of continual rather than periodic watershed disturbance. As a result, most stream channels are in a somewhat 'unnatural' condition, with habitat conditions that are less than optimal for aquatic and riparian-dependent species, which evolved in environments that probably had many more high-quality habitat areas spread across the landscape.

Improving trends in channel conditions have been documented within the project area. For example, in the South Fork Salmon River in Idaho, studies showed a 78 percent reduction in the volume of stored sediment between 1965 and 1989. Excessive sedimentation resulting from a combination of extensive logging, road construction, and wildfire combined with large storm events during the winter of 1964–65, buried prime spawning and rearing habitat in the river. Following a moratorium on logging activities coupled with a watershed restoration and monitoring program, a large volume of fine sediment was moved from the system. Not only was the volume of fine sediment reduced, but the size of particles on the streambed increased, indicating that the sources of sediment have stabilized to some degree (Bohn and Megahan 1991).

Riparian Areas and Wetlands

Background

Riparian areas are water-dependent systems that consist of lands adjacent to streams, rivers, and wetland systems (see Figure 2-15). Riparian ecosystems are the ecological links between uplands and streams, and between terrestrial and aquatic components of the landscape. Riparian areas are defined primarily on the basis of their nearness to lakes, streams, and rivers.

Many riparian areas have *wetlands* associated with them. Wetlands occur wherever the water table is usually at or near the ground, or where the land is at least seasonally covered by shallow water. Wetlands in the project area include marshes, shallow swamps, lake shores, sloughs, bogs, and wet meadows; they are found in both rangeland and forestland environments. Wetlands are an important part of the overall landscape, providing major contributions to ecosystem productivity and structural and biological diversity, particularly in drier climates (Elmore and Beschta 1987).

About 60 percent of the historical wetlands remain within the basin.

Within the project area, wetlands constitute a very small portion of the total land area—less than 1.5 percent. Many wetlands have been drained, filled, pumped dry, or otherwise degraded or lost; about 60 percent of the historical wetlands remain within the basin (compared to a national wetland area of 50 percent of historical remaining). Most of the wetland loss is a result of past draining for agriculture and farming, but smaller wetlands within forest and rangeland riparian areas have been altered or lost from road placement within valley bottoms and other causes.

The largest existing wetland systems in the project area are within the Northern Great Basin and Upper Klamath Basin ERUs, where wetlands occupy the bottoms of closed basins. These large lake / wetland systems naturally shrink and expand in response to climate, and now are also affected by irrigation and water withdrawal. Many small, isolated wetlands exist in alpine areas in the Upper Klamath Basin, Northern Cascades, Southern Cascades, Blue Mountains, and Northern Glaciated Mountains. These wetlands are mostly remnants of small lakes, or have formed in small closed depressions formed by glaciation, landslides, or lava flows.

Physical Processes in Riparian Areas and Wetlands

Important physical processes in riparian areas primarily relate to the interactions among stream channels, adjacent valley bottoms, and riparian vegetation, which depend on the frequency of floodplain inundations (flooding). Water that infiltrates into the floodplain during periods of high flow, returns to the channel during periods of low flow, contributing a cool source of summer base flow for many streams, especially in low-elevation alluvial valleys. Seasonal inundation of the floodplain results in overbank deposition and enrichment of riparian soils. Inundation of the floodplain also reduces water velocities during flooding and helps reduce downstream flood peaks, both factors that reduce the risk of channel

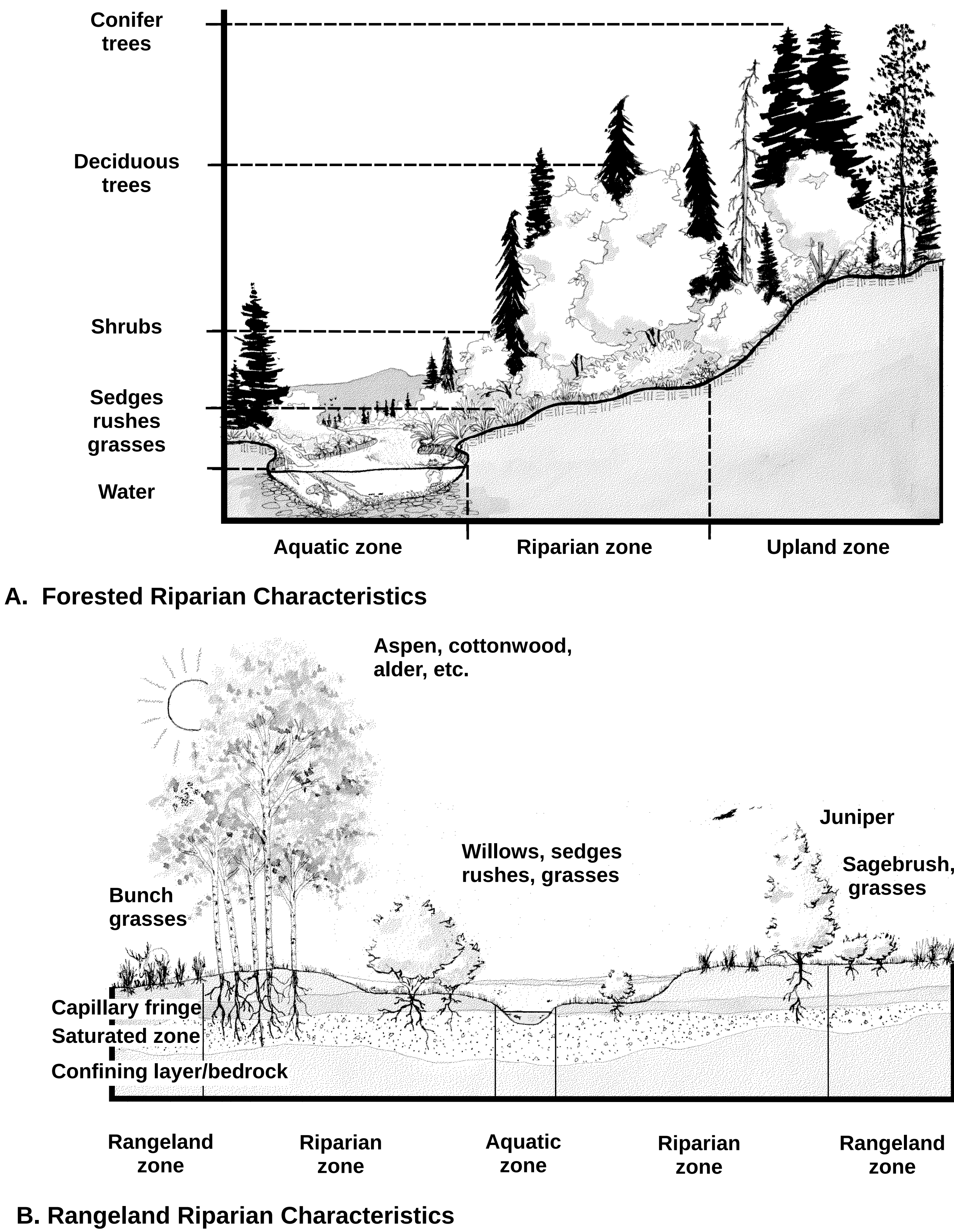

Figure 2-15. Forestland and Rangeland Riparian Characteristics.

Wetlands — A Definition

The U.S. Army Corps of Engineers, Environmental Protection Agency, Fish and Wildlife Service, and Natural Resource Conservation Service worked together to develop common language and criteria for the identification and delineation of jurisdiction wetlands in the United States (Federal Interagency Committee for Wetland Delineation 1989). The four federal agencies defined wetlands as possessing three essential characteristics: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology, which is the driving force creating all wetlands. The three technical characteristics specified are mandatory and must all be met for an area to be identified as a wetland.

"Hydrophytic vegetation" is defined as plant life growing in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. "Hydric soils" are defined as soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic (without oxygen) conditions in the upper part of the soil profile. Generally, to be considered a hydric soil, there must be saturation at temperatures above freezing for at least seven days. "Wetland hydrology" is defined as permanent or periodic inundation, or soil saturation to the surface, at least seasonally. The presence of water for a week or more during the growing season typically creates anaerobic conditions in the soil, which affects the types of plants that can grow and the types of soils that develop (Hansen et al. 1995).

erosion. Inland wetlands perform many of the same functions, such as detaining storm runoff, reducing flow peaks and erosion potential, retaining and filtering sediment, and augmenting groundwater recharge by storing water and releasing it more slowly, later into the dry season.

Riparian and Wetland Vegetation

Most riparian and wetland areas within the project area stand out because of their unique vegetation. In drier regions, ribbons of dense vegetation flank streams and rivers, in distinct contrast to the surrounding uplands and valley bottoms.

Riparian vegetation plays a role in many physical processes within riparian areas. Vegetation shades streams and moderates water temperatures by helping keep waters cool in the summer and providing an insulating effect in the winter. Densely vegetated riparian areas buffer the input of sediment from hillslopes and filter fertilizers, pesticides, herbicides, and sediment from runoff generated on adjacent lands. Riparian vegetation also promotes bank stability and contributes organic matter and large woody debris to some stream systems, which is an important component of instream habitat (Gregory et al. 1991; Henjum et al. 1994; Hicks et al. 1991; Kovalchick and Elmore 1992; Sedell et al. 1990). Complex off-channel habitats, such as backwaters, eddies, and side channels, are often formed by the interaction of streamflow and riparian features such as living vegetation and large woody debris (Gregory et al. 1991). These areas of slower water provide critical refuge during floods for a variety of aquatic species, and serve as rearing areas for juvenile fish.

The broad-scale analysis of vegetation (Hann, Jones, Karl, et al. 1997) identified three potential vegetation groups associated with riparian areas: riparian woodland (dominated by cottonwood, aspen, ponderosa pine, and Douglas-fir), riparian shrub (dominated by alder and willow), and riparian herb (including sedges, forbs, and grasses; see Table 2-25). Because riparian vegetation grows in thin strips along streams and rivers, it was difficult to accurately determine the extent of riparian area using a broad-scale analysis during the *Assessment*. To augment the broad-scale analysis, 337 subwatersheds within 43 subbasins were randomly selected for further analysis on riparian vegetation trends (Hessburg et al. 1995; Hessburg et al. in press).

Under natural conditions, riparian plant communities have a high degree of structural and compositional diversity, reflecting the history of past disturbances such as floods, fire, wind, grazing, plant disease, and insect outbreaks (Gregory et al. 1991). Historically, disturbance regimes along riparian areas were dominated by floods and fires, with some grazing by native ungulates (large, hoofed mammals, such as

Table 2-25. Cover Types-Structural Stage Combinations Within Terrestrial Communities Within the Riparian Potential Vegetation Groups (PVGs), and Associated Terrestrial Families.

Terrestrial Community	Cover Type	Structural Stage	Terrestrial Family
Riparian Herb PVG			
Riparian Herbland Terrestrial Community	Herbaceous Wetlands	Closed Herbland	5, 10, 11, 12
Upland Herbland Terrestrial Community	Native Forbs	Closed Herbland	5, 8, 10, 12
Riparian Shrub PVG			
Riparian Shrubland Terrestrial Community	Shrub Wetlands	Closed Low Shrub	3, 5, 6, 7, 12
		Open Low Shrub	3, 5, 6, 7, 12
		Closed Tall Shrub	3, 5, 6, 7,12
Riparian Herbland Terrestrial Community	Herbaceous Wetlands	Closed Herbland	5,10, 11, 12
		Open Herbland	5, 10, 11, 12
Upland Herbland Terrestrial Community	Wheatgrass Bunchgrass	Closed Herbland	3, 5, 8, 10, 12
Upland Shrubland Terrestrial Community	Salt Desert Shrub	Open Mid Shrub	5, 7, 10, 11
Exotic Herbland	Exotic Forbs/ Annual Grass	Open Herbland	10
Riparian Woodland PVG			
Riparian Woodland Terrestrial Community	Aspen	Stand-initiation Forest	2, 3, 4, 5, 6, 7, 8
		Stem Exclusion Closed Canopy Forest	3, 5, 7
		Understory Reinitiation Forest	2, 3, 5, 6, 7
		Young Multi-story Forest	unmanaged: 2, 3, 5, 6, 7 managed: 3, 5, 7
	Cottonwood/Willow	Stand-initiation Forest	2, 3, 5, 6, 7
		Stem Exclusion Closed Canopy Forest	5, 6, 7
		Understory Reinitiation Forest	3, 5, 6, 7
		Young Multi-story Forest	unmanaged: 1, 2, 5, 6, 7 managed: 1, 5, 6, 7
Riparian Shrubland Terrestrial Community	Shrub Wetlands	Closed Mid Shrub	3, 5, 6, 7, 12
		Open Mid Shrub	3, 5, 6, 7, 12
	Closed Tall Shrub		3, 5, 6, 7, 12
Mid Seral Lower Montane Forest	Interior Ponderosa Pine	Understory Reinitiation Forest	2, 3, 5, 6, 7
Late Seral Lower Montane Single Story Forest		Old Single Story Forest	1, 2, 3, 5, 6, 7, 8
Late Seral Lower Montane Multi-story Forest		Old Multi-story Forest	1, 2, 3, 5, 6, 7
Early Seral Montane Forest	Shrub or Herb/ Tree Regen	Closed Mid Shrub	2, 3, 5
Mid Seral Montane Forest	Interior Douglas-fir	Young Multi-story Forest	unmanaged: 2, 3, 5, 6, 7 managed: 3, 5, 6, 7
Late Seral Montane Multi-story Forest	Interior Douglas-fir	Old Multi-story Forest	1, 2, 3, 5, 6, 7
Upland Herbland	Fescue-Bunchgrass	Closed Herbland	5, 8, 10, 12
Exotic Herbland	Exotic Forbs/Annual Grass	Closed Herbland	10

Source: Developed from Hann, Jones, Karl, et al. 1997 (Appendices 3A, 3B, 3F); and Wisdom et al. (in press).

deer, elk, and antelope). Within the riparian woodland potential vegetation group, fires were normally infrequent but severe (lethal or mixed), occurring at 65- to 150-year recurrence intervals when there were appropriate weather, fuel, and ignition conditions (Hann, Jones, Karl et al. 1997). Flood cycles historically occurred on 10- to 20-year intervals, with floods on larger streams less frequent. In the riparian shrub potential vegetation group, fire was typically more frequent, occurring every 25 to 50 years. Most of these fires were non-lethal or mixed. Historically, flood cycles occurred at 20- to 30-year intervals, with floods on larger streams less frequent. Hann, Jones, Karl, et al. (1997) did not report disturbance interval information for the riparian herb potential vegetation group.

Current Conditions and Trends: Riparian Areas and Wetlands

Riparian Areas

Key broad-scale trends identified in Hann, Jones, Karl, et al. (1997) include a reduction in riparian area abundance and an increase in habitat fragmentation and simplification within the project area. The riparian woodland potential vegetation group declined slightly (less than one percent) from historical. While this trend was confirmed by Hessburg et al. (1995), they also reported *increases* in woodlands in some regions of the project area because of conversion of riparian shrubland to juniper stands. However, although the riparian woodland did not decline substantially in area, the diversity of its terrestrial communities has declined. Historically, approximately 60 percent of the riparian woodland was composed of mid seral terrestrial communities. Currently, mid seral terrestrial communities make up nearly 90 percent of the riparian woodland. Fire suppression, timber harvest, and possibly declines in flood frequency on larger streams were causes of this shift.

The riparian shrubland potential vegetation group has declined 80 percent within the project area (Hann, Jones, Karl, et al. 1997). Analysis conducted by Hessburg et al. (1995) confirmed this declining trend, which occurred mainly on non-BLM- or Forest Service-administered lands because of excessive livestock grazing pressure, invasion of exotic plants, and agricultural and urban developments. Additionally, some loss is the result of succession into forest cover types such as juniper, ponderosa pine, and Douglas-fir, mainly from fire exclusion. No information was reported for the riparian herb potential vegetation group.

Hessburg et al. (in press) conducted further analysis on the distribution and extent of riparian and wetland areas within the project area. They compared vegetation changes over a 40- to 60-year time period using aerial photographs. Within the project area, they sampled 337 randomly selected subwatersheds mainly dominated by Forest Service- or BLM-administered lands. Results indicated that the extent of riparian and wetland vegetation declined in nonforest areas while it increased in forested areas. They concluded that the increase in riparian and wetland extent was due to fire suppression which allowed valley bottom and adjacent side slope vegetation to develop and express itself in the absence of disturbance.

In the western United States, 66 percent of inventoried BLM-administered riparian areas are either "non-functioning" or "functioning at risk."

In addition to geographical extent, functionality (such as water storage and shade) is another important component of riparian areas. In the western United States, 66 percent of inventoried BLM-administered riparian areas are either "non-functioning" or "functioning at risk" as defined in the process for assessing Proper Functioning Condition (see sidebar). Likewise, more than 75 percent of riparian areas administered by the Forest Service in the western United States are not "meeting or moving toward objectives" (USDI BLM 1994b).

Large trees within riparian areas make up an important functional component. Large trees provide valuable habitat for many riparian-dependent terrestrial species, and they provide shade and aquatic habitat. Hessburg et al. (1995) analyzed the extent of large trees within riparian areas over a 40- to 60-year time interval within the project area. They reported a general trend toward reduction in large riparian trees primarily through timber harvest.

Photo #15

Not available in PDF.

Photo by Doug Basford.

Riparian vegetation plays an important role in stream process and function.

Proper Functioning Condition - A Definition

In response to the growing concerns over the integrity of ecological processes in many riparian areas and wetlands, the BLM has developed a process for assessing "Proper Functioning Condition." The BLM's Riparian-Wetland Initiative for the 1990s (USDI BLM 1991a and 1993) establishes national goals and objectives for managing riparian-wetland resources on BLM-administered lands. This initiative's two-part goal is to: (1) restore and maintain existing riparian-wetland areas so that 75 percent or more are in Proper Functioning Condition, and (2) to achieve and provide the widest variety of habitat diversity for wildlife, fish, and watershed protection.

Riparian-wetland areas achieve Proper Functioning Condition when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high water flows. This thereby reduces erosion and improves water quality; filters sediment, captures bedload, and aids floodplain development; improves floodwater retention and groundwater recharge; develops root masses that stabilize streambanks against cutting action; develops diverse ponding and channel characteristics to provide habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and supports greater biodiversity. The functioning condition of riparian-wetland areas is a result of the interaction among geology, soil, water, and vegetation (USDI BLM 1993). Proper functioning condition can exist anywhere along the seral continum, from early seral to potential natural community depending upon the characteristics of the riparian-wetland area (Hann, Jones, Karl, et al. 1997). Although proper functioning condition is viewed by the BLM as the minimum acceptable condition, management objectives might require vegetation composition, cover, or structure that are representative of advanced seral states. Achievement of advanced ecological status, high similarity to potential natural community, is the ultimate goal on federal rangeland riparian-wetland areas (Barrett et al. 1993 as cited in Hann, Jones, Karl, et al. 1997; U.S. Department of Interior 1990 as cited in Hann, Jones, Karl, et al. 1997).

On Forest Service- or BLM-administered lands within the project area, major factors contributing to the decrease in riparian area function are: excessive livestock grazing pressure, timber harvesting, fire management, conversion to crop and pastureland, road development, and dams, diversions, and / or pumping. On rangelands, excessive livestock grazing pressure has been the most important factor affecting riparian areas. On forested landscapes, silvicultural practices (including fire suppression) and road building have had the highest effects on riparian areas. To a lesser extent, disturbances associated with recreational uses, urban development, and mining have also contributed to the decrease in functioning riparian areas.

Although declining riparian conditions occur in many areas, over the past decade land management agencies working cooperatively with the land users have concentrated restoration efforts in riparian areas, and many areas are recovering. An example of improved rangeland riparian condition is the Big Cottonwood Creek watersheds on the Sawtooth National Forest in Idaho, where an improving trend has occurred in the past five to seven years (see photos). Bare soil and muddy wet areas are now covered with grasses, with wetlands being created and willows growing along the streambank. The improvement has resulted from improved management by the permittees.

Wetlands

Since European settlement, many wetlands on private lands have been drained, filled, sprayed with herbicides and pesticides, or logged, primarily to develop lands for agriculture, but also for residential, commercial, and industrial development. Additionally, wetland habitats have been affected by the invasion of non-native plants (such as purple loosestrife, saltcedar, and Russian olive) and introduced animals (such as bullfrogs). On many sites, these non-native species have become well established, commonly replacing native species or exerting large influences on the functional dynamics of existing native habitats.

Most of the remaining high quality wetlands in the project area are on BLM- or Forest Service-administered lands, primarily in alpine or sub-alpine environments, and on other federally managed lands such as National Wildlife Refuges managed by the U.S. Fish and Wildlife Service. Artificial wetlands also contribute significantly to wetland habitats within the project area. These areas, such as Malheur Lake in eastern Oregon and those in the Columbia Plateau, were created by flow impoundment, irrigation ponds, stream diversion, and agricultural wastewater.

Water Quality

Background

As specified in the Clean Water Act, water quality includes those attributes that affect existing and designated uses of a water body. Included are human uses such as recreation, hydropower, and water supply, and other uses such as maintenance of fisheries and riparian habitats. As a result, water quality attributes that are considered under the Clean Water Act include traditional physical and chemical constituents such as pH, bacteria concentration,

Water Quality and the Clean Water Act

Water quality is regulated by state environmental agencies under authority granted by the Clean Water Act (1972) and subsequent amendments. Under the Clean Water Act, federal agencies are, in general, required to meet state requirements. In the upper Columbia River Basin, the Forest Service and BLM are the responsible management agencies for water quality on lands they manage, as described in memoranda of understanding (MOUs) with state environmental agencies. These MOUs require federal agencies to meet water quality standards, monitor activities to assure they meet standards, report results to the states, and meet periodically to recertify Best Management Practices (BMPs), which are practices designed to prevent or reduce water pollution. The primary mechanisms for regulating and controlling non-point sources of pollution are adopting and implementing (1) Best Management Practices, (2) numeric and narrative water quality standards, and (3) the antidegradation policy (40 CFR 131).

Big Cottonwood Creek — Then and Now

Photo #16

Not available in PDF.

Photo by USFS/Sawtooth NF.

1986. Big Cottonwood Creek, Twin Falls Ranger District. Mature trees are mostly dead, and there is no regeneration of willow or cottonwood due to heavy browsing by cattle.

Photo #17

Not available in PDF.

Photo by USFS/Sawtooth NF.

1990. Total rest in 1988 and 1989 and light fall use in 1990 allowed release of willow and cottonwood.

Photo #18

Not available in PDF.

Photo by USFS/Sawtooth NF.

1992. Light use in the spring of 1991, and spring use in 1992. 400 cow-calf pairs used this unit for 10 days just prior to this photo being taken.

temperature, discharge, and factors relevant to aquatic habitat such as the abundance of large woody debris, pool frequency, and riparian canopy density.

Water temperature is a water quality parameter considered under the Clean Water Act and is a regionally important facet of aquatic habitat required to support beneficial uses on Forest Service- and BLM-administered lands within the project area. The relationship between land use practices, water temperature, and effects on fish species is better understood than for any other aspect of water quality (Rhodes et al. 1994). Water temperature influences metabolism, behavior, and mortality of aquatic species (Beschta et al. 1987; Bjornn and Reiser 1991). Salmonids (salmon and trout) are cold-water fish that are particularly sensitive to increases in temperature; sustained water temperatures of higher than 64 to 80 degrees Fahrenheit are lethal for most species.

On public lands in the basin, non-point sources of pollution are the primary cause of degraded water quality. A non-point source of pollution is water pollution whose source(s) cannot be pinpointed, but that can be best controlled by proper soil, water, and land management practices.

The Clean Water Act requires each state to review all available information on water quality every two years as part of a statewide water quality assessment. Where application of current Best Management Practices (BMPs) or technology-based controls are not sufficient to achieve designated water quality standards, the water body is classified as "water quality limited." Water bodies having impaired water quality are in part identified on the respective states' 303(d) lists. A protocol for addressing restoration and maintenance of 303(d) waters on BLM- and -Forest Service administered lands was developed collaboratively and adopted for the area included in the project area. Application of this 303(d) protocol would provide reasonable assurance that listed and threatened waters, as well as waterbodies not meeting water quality standards, will be addressed in a consistent manner at an appropriate scale and level of technical rigor. This protocol was developed and adopted after publication of the ICBEMP Draft EISs.

Current Conditions and Trends: Water Quality

About 10 percent of the streams and rivers within the project area are potentially water quality limited. Approximately 8 percent of stream mileage on Forest Service- and BLM-administered lands are listed as potentially water quality limited and, therefore, not in full support of beneficial uses (Lee et al. 1997).

On Forest Service-administered lands in the project area, the primary water quality concerns are sedimentation and turbidity, flow alteration (water quantity), and high water temperatures during summer months. On BLM-administered lands, high sediment and turbidity levels and high temperatures are the primary reasons for listing as water quality limited.

In the project area, where summer air temperatures are generally much higher than 80 degrees Fahrenheit, many streams have lost their capability to support cold-water fish, and salmonid mortality due to elevated water temperatures is common in streams that still support salmonids (Henjum et al. 1994).

Fish and Other Aquatic Species

Background

Fish are the dominant aquatic vertebrates and constitute a key component of aquatic ecosystems in the project area (Figure 2-16). Fish are a critical resource to humans and have influenced the development, status, and success of social and economic systems within the project area. Fish are sensitive to disturbance, thus including the effects of landscape and watershed processes over large regions. The diversity and integrity of native fish communities provide useful indicators of aquatic ecosystem structure, function, and health.

Current Conditions and Trends: Aquatic Species

Like many portions of western North America, the project area has a moderately sized, locally diverse fish fauna. The varied characteristics and distribution of native fishes mirror the diverse and dynamic physiography and geologic history of the region. The native fish fauna of the Columbia River drainage is unusual in that it is not a single unit, but rather is composed of several subbasin faunas with limited species overlap among subbasins. There are presently 143 recognized fish species, subspecies, or races reported within the project area.

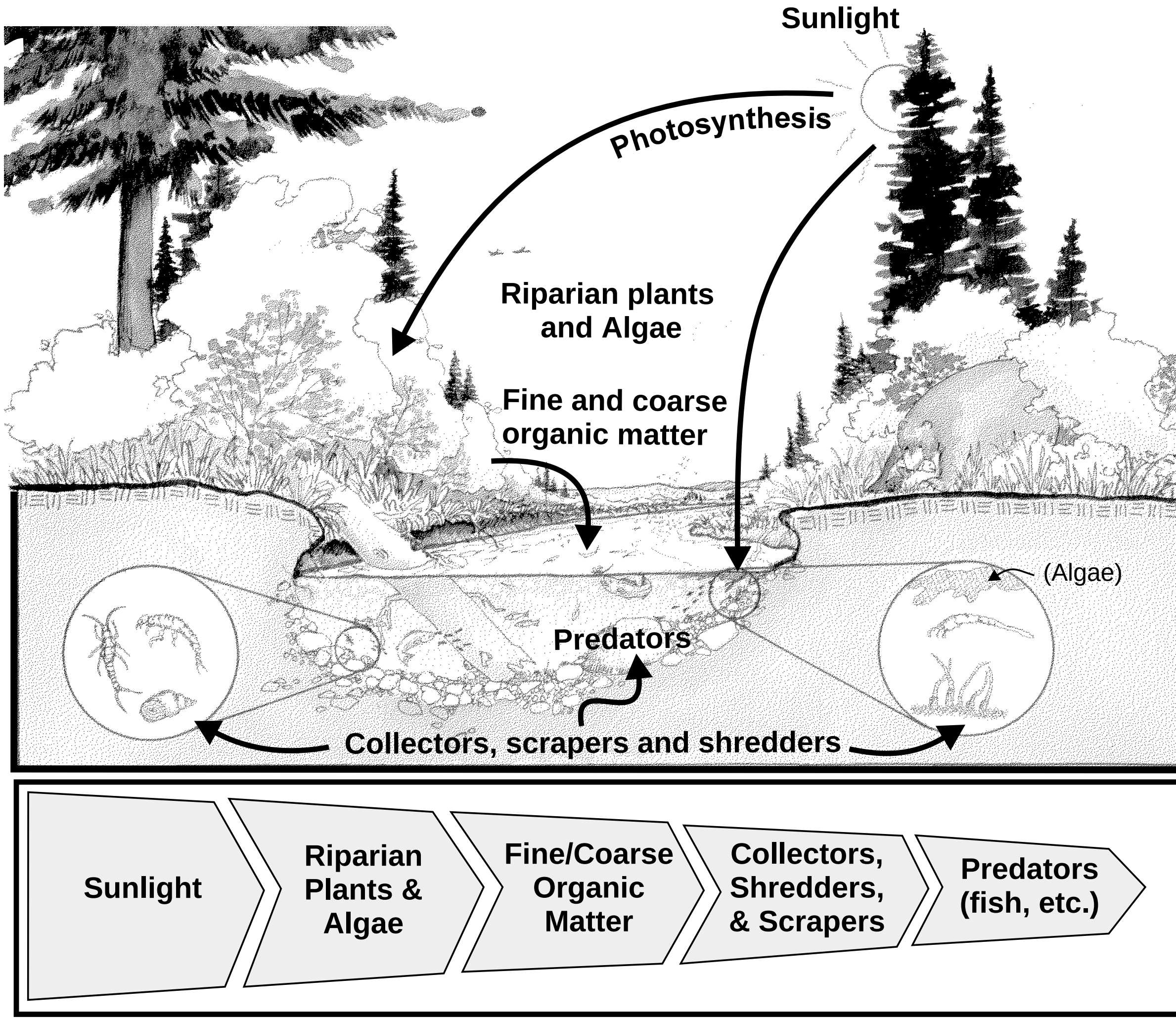

Figure 2-16 Aquatic Food Web. Fish are key components of aquatic ecosystems, where complex food webs include both aquatic and terrestrial plants and animals.

Native Species

Eighty-eight of the project area fish species are native. Compared to other large river systems, species richness (number of species) within the project area is quite low, which may be a reflection of the isolation and geologic history of the project area compared to other large river basins with greater species richness.

In individual watersheds (5th-field Hydrologic Unit Codes) within the project area, the total number of native species ranges from zero to 28. The largest number of native species is found in the large river corridors, particularly the lower and mid-Columbia and lower Snake rivers. Fewer native fish species are found in headwater watersheds in the Blue Mountains and western Montana.

Narrow Endemics

Native fish species tend to fall into two groups. The first group consists of 15 to 20 species that are widely distributed throughout the basin or are reported in 20 percent or more of the project area. The second group of roughly 60 species includes the narrow endemic or rarer species that have restricted ranges or are infrequently reported. These species are generally found in less than five percent of the project area. These species, commonly called narrow endemic species, are found principally in Oregon and southern Idaho. Many of these species are associated with closed basins or are isolated in relatively small watersheds. See Map 2-12.

Map 2-12. Narrow Endemic Species.

The History of Forest Service/BLM Fish Habitat Management

Federally managed lands in the Columbia River Basin contain more than 60 percent of the remaining accessible spawning and rearing habitat for anadromous salmonids. In response to the evidence for declining populations, and the importance of Forest Service- and BLM-administered lands for maintenance and rebuilding of existing populations, these agencies have developed and implemented several strategies intended to maintain and enhance anadromous fish habitat. Another goal of these plans was to meet the goals and objectives of the Northwest Power Planning Council (NWPPC), which was chartered in 1981 to restore a sustainable anadromous fishery within the Columbia River Basin. The Forest Service and BLM have cooperated with the NWPPC, the Bonneville Power Administration (BPA), state fish and game agencies, and tribal governments in an effort to manage anadromous fish habitats.

The Forest Service and BLM have existing land use plans, many that were prepared prior to 1990, which address anadromous and resident fish habitat management. These plans are not species- or watershed-specific. They provide for Forest Service and BLM management to maintain and enhance habitat and to meet existing federal laws such as the Clean Water Act.

In January 1991, the Forest Service developed a Columbia River Basin Anadromous Fish Policy, which set forth a consistent plan for management of anadromous fish habitat within the Columbia River Basin. The policy contained a policy implementation guide, which outlined procedures for establishing objectives for anadromous fish production, described desired future conditions, identified habitat inventory needs, and developed monitoring strategies. This policy is still in place but will be replaced by direction from the Record of Decision developed from this EIS.

The PACFISH strategy, a joint document signed by the Chief of the Forest Service and the Director of the BLM in February 1995, outlines and establishes a strategy for anadromous fish habitat management. PACFISH establishes interim goals and objectives, identified riparian conservation areas and associated protective standards to guide management activities that may damage those areas, outlines monitoring requirements to track how well agencies follow the standards, and evaluates the effectiveness of these measures.

An inland native fish strategy (INFISH) was developed and implemented in July 1995 by the Forest Service to protect resident fish outside of anadromous fish habitat in eastern Oregon, eastern Washington, Idaho, western Montana, and portions of Nevada. The Bureau of Land Management instituted the interim direction and guidelines of INFISH to be applied to BLM lands containing bull trout habitat within the Columbia River Basin in October 1995. This strategy is similar in content to PACFISH.

Both PACFISH and INFISH are interim direction until long-term direction is developed through the ICBEMP Environmental Impact Statement and Record of Decision.

Map 1-3 in Chapter 1 illustrates areas affected by PACFISH and INFISH.

In addition to PACFISH and INFISH, several programmatic Biological Opinions have been completed by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service which provide further guidance for federally listed fish habitat management on large portions of Forest Service- and BLM- administered lands within the project area. These Biological Opinions were completed as a result of Section 7 consultation required by the Endangered Species Act. The Forest Service and BLM must comply with the terms and conditions contained within Biological Opinions when implementing management activities in listed fish habitat. In Chapter 3, Alternative S1 includes these Biological Opinion requirements.

The Upper Klamath and Agency lakes harbor a diverse community of specialized catostomid (sucker) fishes. The Great Basin contains multiple subbasins which have been isolated from each other and the ocean since the Pleistocene Age, approximately 1.6 million years ago. Each basin is now characterized by largely or wholly internal drainage, resulting in highly endemic fish faunas. The distinctive native fishes of both the upper Klamath Basin and Great Basin portions of the project area bear little resemblance to those of the Columbia River Basin. For further information on narrow endemic fish species see Lee et al. (1997). Appendix 2-1 in the Eastside Draft EIS contain maps showing the historical and current distributions of these narrow endemic fish.

Special Status Native Aquatic Species

There are 47 special status fish species in the project area. Special status species include federally listed endangered or threatened species; federal candidate species for listing; species recognized for special protection by the states of Oregon, Washington, Idaho, or Montana; species managed as sensitive species by the Forest Service and/or BLM; and species recognized by the American Fisheries Society. Excluding the widely distributed salmonids, the list of special status species in the project area includes: the white sturgeon (*Acipenseridae*); 5 lampreys (*Petromyzontidae*); sockeye, chum and coho salmon (*Salmonidae*); coastal and Lahontan cutthroat trout (*Salmonidae*); pygmy whitefish (*Salmonidae*); burbot (*Gadidae*); 11 minnows (*Cyprinidae*); 6 suckers (*Catostomidae*); 8 sculpins (*Cottidae*); and Sunapee char, an important introduced species. Twenty-two of these species occur in the Great Basin and Klamath Basin portions of the project area. Within the Columbia River Basin, eight occur entirely or primarily in the mainstream river system, three are restricted to the upper Snake River system (including the Wood River in Idaho), two are restricted to the upper Columbia River (primarily in the Northern Glaciated Mountains), two occupy streams in the middle and upper Columbia Basin, and one is restricted to the Blue Mountains in the middle Columbia River Basin.

Sixteen fish species or species stocks in the project area are formally listed under the Endangered Species Act and one qualifies for listing (candidate species: coho salmon). Within the project area, seven of these species or species stocks are listed as endangered: white sturgeon (Kootenai River), sockeye salmon (Snake River), chinook salmon (Upper Columbia River), steelhead (Upper Columbia River), Borax Lake chub, Lost River sucker, and shortnose sucker. Nine species or species stocks are listed as threatened: steelhead (Snake River and Mid Columbia), fall chinook salmon (Snake River), spring/summer chinook salmon (Snake River), bull trout, Hutton tui chub, Foskett speckled dace, Warner sucker, and Lahontan cutthroat trout.

Six aquatic snails federally listed as endangered or threatened are found in the project area (Frest and Johannes 1995), including the endangered Banbury Springs lanx (*Lanx* sp.), Snake River physa (*Physa natricina*), Idaho springsnail (*Fontelicella idahoensis*), Bruneau hot springsnail (*Pyrgulopsis bruneauensis*), and Utah valvata (*Valvata utahensis*); and the threatened Bliss Rapids snail (*Taylorconcha serpenticola*). According to Frest and Johannes (1995), the lanx, Bliss Rapids snail, and Utah valvata may occur on BLM-administered lands in Idaho. All of these three latter species are local endemics with limited distribution and numbers; the major threats to these species are linked primarily to agriculture and river impoundments. A recovery plan has been developed and approved for five listed Snake River snails that includes delineation of recovery areas.

Major Changes from Draft EISs

Aquatic Species

Since publication of the Draft EISs, bull trout; Snake River, Mid Columbia River, and Upper Columbia River steelhead; and Upper Columbia chinook salmon have been listed under the Endangered Species Act (ESA). See Table 2-24 in the Terrestrial Species section of this chapter. As a result of Section 7 consultation, Biological Opinions were completed or are nearing completion for large portions of Forest Service- and BLM-administered lands within the project area. These Biological Opinions provide further guidance for federally listed fish habitat management.

For additional changes from the Draft EISs, see the box in the Introduction to Chapter 2.

Many factors contribute to the current condition of depressed populations and reduced distribution of special status native aquatic species. Hydroelectric development disrupts migration of anadromous forms. Irrigation diversions and water withdrawal, and the loss of wetlands, marshes, and interconnected waterways, alter habitats for many species, especially in arid regions. Silvicultural practices, excessive livestock grazing pressure, and urbanization degrade habitat by changing flow patterns, changing patterns of sedimentation and erosion, increasing water temperatures, and causing increased levels of organic matter resulting in water pollution. Especially threatened are those species dependent on springs, such as the Foskett speckled dace and the Hutton tui chub. Introduced species also have affected native fish by competition, predation, or hybridization.

Management of many special status species is hindered by a lack of information on species distribution, life history, and habitat characteristics. The best available information is for the salmonids, or for a few select species that have attracted the attention of researchers. More detailed information for wide-ranging salmonids is presented in a subsequent section.

Introduced Species

In addition to the native fishes, 55 species of non-native fish species now occupy the project area. Most of these non-native species have been purposely introduced to promote sport fishing opportunities. Introduced salmonids (such as hatchery rainbow trout), centrarchids (such as bass and sunfish), and percids (such as walleye) now support much, if not most, of the sport fishing opportunity in the project area. The introduced species are now permanent components of the aquatic ecosystem and have social and economic importance. They tend to be well-adapted to altered conditions in aquatic environments and have contributed to the decline of native fish and other native aquatic organisms through competition, predation, and hybridization.

Some of these non-native fish species are now widespread. The most frequently reported fish species in the project area is the introduced rainbow trout, occupying 78 percent of the project area watersheds. Introduced brook trout are also well distributed, occupying 50 percent of the watersheds in the project area. Sixteen of the 50 (32 percent) most-reported species are introduced game fishes.

Recreation centered on non-native fisheries is highly valued within the project area, and many watersheds support important wild trout fisheries for introduced salmonids such as brook, brown, rainbow, and lake trout. Habitat in these watersheds remains suitable for natural reproduction of salmonids, although native salmonids may be depressed or extinct because of displacement by non-native fish. For example, in the Henry's Fork of the Snake River, Idaho, native Yellowstone cutthroat trout are virtually extinct in large portions of their historical range, yet wild, self-sustaining populations of introduced rainbow trout thrive and support an internationally recognized trophy trout fishery. Similarly, the upper Deschutes River in Oregon is a renowned wild trout fishery of non-native brook, brown, rainbow, and lake trout, which have partially displaced native salmonids.

Salmonids

Historical Overview

Salmon, perhaps more than any other single resource, have helped define the Pacific Northwest. Historically, salmon occurred in nearly every stream and river not blocked by major falls. Most American Indians in the project area share a major dependence on salmon and other native fish species as a subsistence and ceremonial resource. Subsequent treaties with some American Indian tribes recognized this major dependence and contained language reserving rights for fishing and the harvest of fish. When the first European settlers arrived during the early 1800s, salmon were abundant and diverse. Estimates of historical run size for all species of salmon and steelhead in the Columbia River range from 10 to 16 million adults. The first commercial cannery operations began on the Columbia in 1866 and soon exceeded sustainable levels. Commercial catches of chinook salmon peaked during 1883, when 43 million pounds of fish were landed. Coho, sockeye, chum, and steelhead were also abundant in the Columbia River Basin. The catch of coho salmon peaked at 6.8 million pounds in 1895, whereas the catch of sockeye and steelhead peaked at 4.5 million and 4.9 million pounds respectively (see Lee et al. 1997; Haynes and Horne 1997).

Overfishing was blamed for broad declines in chinook salmon runs by the late 1800s, and by 1900 certain fishing gear was banned to provide some protection to spawning runs. By that time, however, impacts from mining, timber harvest, excessive livestock grazing pressure, and agriculture (including irrigation diversions) had begun. Construction of massive mainstream dams and dams on smaller streams followed. During and immediately after World War

"Strong" Populations and "Strongholds"

For this discussion, "strong" populations or "stronghold" subwatersheds for key salmonids have the following characteristics:

1. All major life-history forms that historically occurred within the subwatershed are present;
2. Numbers are stable or increasing and the local population is likely to be at half or more of its historical size or density;
3. The population or metapopulation within the subwatershed, or within a larger region of which the subwatershed is a part, probably contains at least 5,000 individuals or 500 adults.

II, timber harvest and road building rapidly increased. Urbanization pressures, river channelization, pollution, and other impacts from the increasing human population began to become evident by the 1960s, as numerous stocks of all species of salmon, steelhead, and sea-run cutthroat trout declined.

Mainstream dams and hydropower operations currently are cited as dominant factors in the decline of the region's anadromous fisheries. Hydroelectric development changed the Columbia and Snake river migration corridors from mostly free-flowing in 1938 to a series of impoundments by 1975, and reservoir storage activities have reduced flows in most years during smolt migration. Major dams in the project area are shown on Map 2-13.

Many resident salmonids (non-anadromous forms such as bull trout), which are not subject to the hydropower operations, are also declining. However, bull trout, once widely distributed in central Oregon, Washington, Idaho, and western Montana has been listed as threatened under the Endangered Species Act. Strong and genetically pure populations of westslope cutthroat trout now occupy only a fraction of their range in the project area. Redband trout within the Columbia Basin are poorly understood, yet many subbasins appear to contain declining populations of genetically unique strains. Such significant declines in resident stream salmonid populations indicate broad changes in aquatic conditions within the project area. Overall changes in the distribution of salmonid species are portrayed on Map 2-14 and Map 2-15.

Key Salmonids

Bull trout, westslope cutthroat trout, Yellowstone cutthroat trout, redband trout, steelhead, and stream-type chinook are "key salmonids" that were selected by the Science Integration Team as being broadly representative of the state of aquatic biota in the project area. The Broad-scale Assessment of Aquatic Species and Habitats (Lee et al. 1997) focused on this select group of salmonids for several reasons:

1. This group of fishes has important social and cultural values;
2. Knowledge about these fishes is greater than for other species, and thus environmental relationships are likely to be more apparent;
3. These fishes are widely distributed, which allows for broad-scale comparisons;
4. Salmonids act as predators, competitors, and prey on a variety of other aquatic and terrestrial species, and are therefore likely to influence the structure and function of aquatic ecosystems, and may serve as links to energy and nutrient flows with terrestrial systems;
5. Different salmonid species and different life stages of a species often use widely divergent habitats that expose individual populations to a wide variety of threats, thus integrating cumulative effects of environmental change over broad areas; and
6. The status of these key salmonids can be thought of as a general indicator of aquatic ecosystem health. Problems encountered by these species probably can be assumed to be similar to those facing many aquatic species throughout the project area.

Bull Trout

Bull trout are listed under the Endangered Species Act as threatened in the Columbia and Jarbidge river basins and endangered in the Klamath River Basin. Bull trout are found in many of the major river systems within the project area, but spawning and

Map 2-13. Major Dams.

Map 2-14. Key Salmonid Distribution: Historical.

Map 2-15. Key Salmonid Distribution: Current.

Historically, bull trout populations were well connected throughout the Columbia River Basin. Habitat available to bull trout has been fragmented, and in many cases, entirely isolated.

rearing populations are believed to be primarily restricted to cold and relatively pristine waters, often headwaters, of most rivers. Current and historical distributions of bull trout are illustrated on Map 2-16.

The historical range of bull trout is restricted to North America. Within the project area, bull trout have been recorded in the upper Klamath River Basin in Oregon, and throughout much of interior Oregon, Washington, Idaho, and western Montana. With the exception of the Little Lost and Big Lost rivers, bull trout are not known in the Snake River basin above Shoshone Falls. It is estimated that the historical range of bull trout included about 60 percent of the project area. It is unlikely, however, that bull trout occupied all accessible streams at any one time because of climate and habitat selection.

Bull trout are presently known or estimated to occur in 44 percent of historically occupied watersheds. Bull trout are still widely distributed throughout the project area, with the largest population blocks in north central Idaho and northwestern Montana. The core of the remaining bull trout distribution is tied to the Central Idaho Mountains, with important strongholds still evident or likely within the Upper Clark Fork, Northern Glaciated Mountains, Lower Clark Fork, and Blue Mountains ERUs. Bull trout in the Owyhee Uplands represent an important area of genetic diversity. A small population exists in the Jarbidge River, which represents the present southern limits of the species range. Current information indicates that despite its relatively broad distribution, this species has experienced widespread decline. There is evidence of declining trends in some populations, and recent extirpations of local populations have been reported. Distribution of existing populations is often patchy, even where numbers are still strong and habitat is good.

Spawning and rearing of bull trout appear to be limited to the coldest streams or stream reaches. The lower limits of habitat used by bull trout are strongly associated with gradients in elevation, longitude, and latitude that may approximate a gradient in climate across the project area. The patterns indicate that variation in climate has influenced and will strongly influence habitat available for bull trout. While temperatures are probably suitable throughout much of the northern portion of the range, spawning and rearing habitat is restricted to increasingly isolated high elevation or headwater "islands" toward the south.

Management-related changes influencing stream temperatures and hydrologic regimes are all likely to be important to some, if not most, populations. Populations are likely to be most sensitive to changes in headwater areas encompassing critical spawning and rearing habitat and remnant populations.

More than 30 non-native species occupy the present distribution of bull trout. Brown trout, brook trout, and lake trout have probably depressed or replaced many local bull trout populations. Brook trout are an especially important competitor and may progressively displace bull trout through hybridization and a higher reproductive potential. Brook trout now occupy the majority of watersheds representing the current range of bull trout. These non-native fish may pose the most risk to native species at sites where habitat has been affected by other disturbances.

Historically, bull trout populations were well connected throughout the Columbia River Basin. Habitat available to bull trout has been fragmented, and in many cases, entirely isolated. Dams have isolated whole subbasins throughout the project area. Irrigation diversions, culverts, and degraded mainstem habitats have eliminated or seriously affected migratory corridors, thus depressing migratory populations and effectively isolating remnant populations in headwater tributaries. Loss of suitable habitat through watershed disturbance may also increase the distance between quality habitats and between strong populations, thus reducing the likelihood of effective dispersal and gene mixing. Further isolation of populations will probably lead to increasing rates of extinction that are disproportional to the simple loss of habitat area.

Yellowstone Cutthroat Trout

The Yellowstone cutthroat trout is more abundant and inhabits a larger geographical range than any other non-anadromous subspecies of cutthroat trout in the western United States. Yellowstone cutthroat trout were historically found throughout the Yellowstone River drainage in Montana and Wyoming and in the Snake River drainage in Wyoming, Idaho, Utah,

Yellowstone cutthroat trout support the largest proportion of strong populations of any key salmonid in the project area.

Map 2-16. Bull Trout Distribution: Historical and Current.

Nevada, and probably Washington. It is the only native trout in the Snake River above Shoshone Falls. Its historical range included primarily the Upper Snake and Snake Headwaters where 74 percent and 98 percent, respectively, of the watersheds once supported Yellowstone cutthroat trout. Individual populations of Yellowstone cutthroat trout have evolved numerous life-history characteristics in response to the diverse environments in which they have been isolated since the Pleistocene ice age.

There has recently been a substantial reduction in the distribution of this subspecies, and many unique local populations have been lost. As a result, the Yellowstone cutthroat trout has been designated as a "Species of Special Concern - Class A" by the American Fisheries Society. This status has been officially recognized by the Montana Department of Fish, Wildlife, and Parks. The Yellowstone cutthroat trout is recognized as a "Species of Special Concern" in Idaho. Both the Northern and Rocky Mountain regions of the Forest Service and BLM consider the Yellowstone cutthroat trout a sensitive species. Yellowstone cutthroat trout have been petitioned for listing under the Endangered Species Act. Current and historical distributions of Yellowstone cutthroat trout are illustrated on Map 2-17.

Within the project area, Yellowstone cutthroat trout are presently the most narrowly distributed of the key salmonids. The current known and estimated distribution includes 70 percent of its historical range within the project area. The core population is in the Snake Headwaters. Populations are widespread in the Upper Snake, but most are depressed. Remaining populations on the western edge of the range appear to be isolated in small areas. Population declines and losses have been most common in low elevation, higher order streams, as illustrated by the current distribution and status of Yellowstone cutthroat trout in the Upper Snake. Remoteness of portions of the native range probably contributes to the preservation

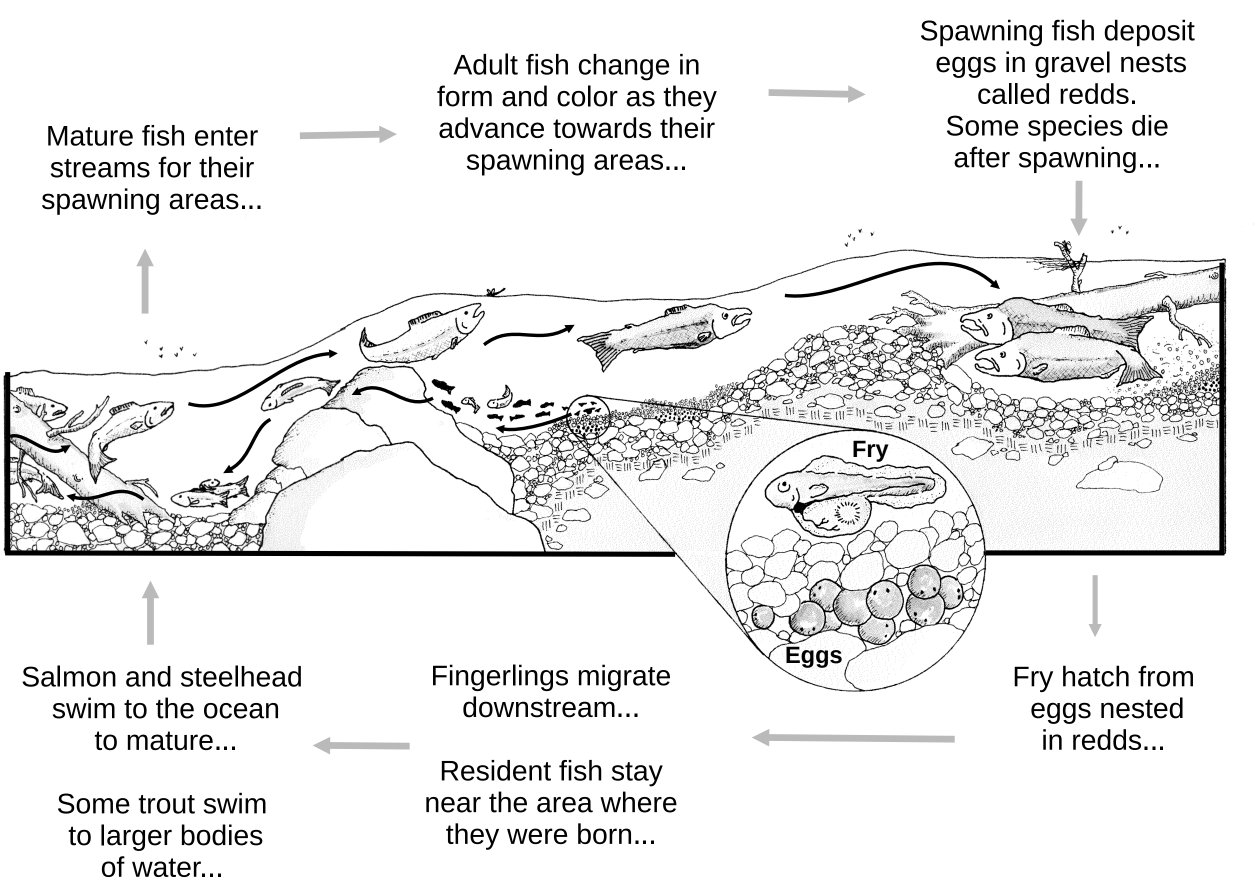

Figure 2-17. Salmon and Trout Life Cycles. Salmon and trout are among the aquatic species whose life cycles have evolved in concert with the dynamic nature of stream channels. All of their life history forms must be present for a subwatershed to be considered "strong."

of remaining populations. Many of these publicly owned portions of the native range, in the form of parks and reserves, have provided habitat protection that is lacking in low elevation portions of the range.

Despite their narrow distribution, Yellowstone cutthroat trout are judged to support the largest proportion of strong populations of any key salmonid. These estimates of strong populations may be misleading because of high probability of hybridization in most populations. Hybridization resulting from introductions of rainbow trout and non-native subspecies or populations of cutthroat trout is the primary cause of the decline and extirpation of Yellowstone cutthroat trout. Genetically unaltered populations of Yellowstone cutthroat trout occur in approximately 10 percent of their historical stream habitats and approximately 85 percent of their historical lake habitats. Approximately 90 percent of the present range of genetically unaltered Yellowstone cutthroat trout is within Yellowstone National Park.

Human activities such as dam construction, water diversions, improper livestock grazing, mineral extraction, road construction, and timber harvest have degraded stream environments throughout the historical range of Yellowstone cutthroat trout. Recreational use can also be a source of disturbance. In the range of this species, excessive livestock grazing pressure on private and public lands in the upper Snake River Basin has caused degradation of riparian areas, including stream bank erosion and channel instability.

Westslope Cutthroat Trout

Westslope cutthroat trout were once abundant throughout much of the north and central interior Columbia River Basin. Although still widely distributed, remaining populations may be seriously compromised by habitat loss and hybridization. They are presently considered a sensitive species by the Forest Service and BLM, and of special concern by state management agencies in Washington, Oregon, Idaho, and Montana. Westslope cutthroat have been petitioned for listing under the Endangered Species Act and is currently under status review by the U.S. Fish and Wildlife Service. Current and historical distribution of westslope cutthroat trout are illustrated on Map 2-18.

Westslope cutthroat trout had the largest historical distribution of all subspecies of cutthroat trout. Cutthroat trout were first recorded by the Lewis and Clark expedition. From early explorer accounts, it is believed they were extremely abundant. Where habitat was suitable and watersheds were accessible, westslope cutthroat trout were commonly found. Westslope cutthroat trout probably also occupied most of the large natural lakes within their range. The historical range of westslope cutthroat trout encompassed about 35 percent of the project area.

Westslope cutthroat trout are still widely distributed within their historical range, with some extension through hatchery introductions. It is estimated that westslope cutthroat trout are still present in at least 85 percent of their historical range. This broad distribution suggests that, overall, westslope cutthroat trout are secure, but this conclusion must be tempered by uncertainty regarding the genetic integrity of remaining populations. Most current wild populations are depressed, and hybridization, fragmentation, and the loss of migratory populations have limited healthy populations to a much smaller proportion of their historical range.

The core of the distribution for strong populations is associated with the Central Idaho Mountains, where many populations do appear secure. Other important blocks of known or likely habitat are in the Upper Clark Fork and Northern Glaciated Mountains ERUs, although these areas are more fragmented and populations are restricted to a relatively small portion of the historical distribution. The Northern Cascades may support important populations of westslope cutthroat trout which are geographically distinct from the main distribution. Westslope cutthroat trout probably were never widely distributed within the Blue Mountains or Columbia Plateau.

Cutthroat trout and rainbow trout are closely related, but they have remained reproductively distinct where they co-evolved. Where non-native rainbow trout have been introduced, hybridization is widespread. Yellowstone cutthroat have also been introduced into much of the westslope cutthroat trout range, and hybridization is common between these two subspecies. Hybridization was believed to be the most important cause for decline of westslope cutthroat trout populations in Montana.

The westslope cutthroat trout is also a prized game fish, and fishing has probably led to the elimination of some small populations, especially migratory fish in some river systems. Consequently, special harvest

Most existing strong populations of westslope cutthroat trout are largely in roadless and wilderness areas or national parks, suggesting that human disturbances have influenced distribution and abundance.

Map 2-17. Yellowstone Cutthroat Trout Distribution: Historical and Current.

Map 2-18. Westslope Cutthroat Trout Distribution: Historical and Current.

restrictions have been implemented to improve or maintain most westslope cutthroat trout populations.

Most existing strong populations are largely in roadless and wilderness areas or national parks, suggesting that human disturbances have influenced distribution and abundance. In general, strong populations are thought to be primarily associated with areas of limited human influence and the associated potential effects of fishing, watershed disturbance, and non-native fish introductions.

Construction of dams, irrigation diversions, or other migration barriers have isolated or eliminated westslope cutthroat trout habitats that once were available to migratory populations. Resident forms may persist in isolated segments of streams, but the potential for long-term persistence is compromised by the loss of migratory life-history and lack of connectivity with other populations potentially important to gene flow or population dynamics.

Redband Trout (“Resident” and “Resident–Interior”)

The redband trout (native rainbow trout) is a widely distributed western North America native salmonid. Of the key salmonids, redband trout originally had the widest distribution, occupying 73 percent of the watersheds within the project area. The only major portions of the project area that historically did not support redbands were the Snake River upstream from Shoshone Falls, tributaries to the Spokane River above Spokane Falls, and portions of the northern Great Basin in Oregon.

Redband trout within the project area have two distinct life histories, anadromous (steelhead) or non-anadromous (freshwater resident). For purposes of the *Scientific Assessment*, freshwater resident redbands were further divided into “resident–interior” (native non-anadromous redband trout outside the range of the steelhead) and “resident” (those populations that exist within the range of steelhead). Current and historical distributions of redband trout are illustrated on Map 2-19.

Resident and resident-interior redband trout are considered species of special concern by the American Fisheries Society and by all states within the project area. They are classified as a sensitive species by the Forest Service Pacific Northwest and Northern regions and the BLM. The Great Basin resident-interior population has been petitioned for listing under the Endangered Species Act and is currently under status review by the U.S. Fish and Wildlife Service.

Collectively, resident and resident-interior redband trout currently may be the most widely distributed key salmonid in the project area. However, despite their broad distribution, relatively few strong resident redband populations exist.

Less is known about the current distribution of redband trout than any of the other key salmonids. One reason for the lack of information is the inability to differentiate juvenile steelhead and resident redbands. Therefore the status of resident redbands was considered “unknown” when steelhead were present in a watershed. However, it is believed that collectively, resident and resident-interior redband trout currently may be the most widely distributed key salmonid in the project area.

The known and estimated distribution of both forms of non-anadromous redbands include 65 percent of the historical range. Resident redbands are the more widely distributed of the two forms; their known and estimated distribution includes 69 percent of the historical range. The largest areas of unoccupied historical habitat are in the Owyhee Uplands and Columbia Plateau ERUs. Resident-interior redbands are not as widely distributed and are currently found or estimated in 50 percent of the identified historical range. The distribution of native redband trout may be less than the above estimates indicate because of hybridization with stocked rainbow trout. Preliminary status reviews in Idaho, Oregon, and Montana generally support this concern.

Despite their broad distribution, relatively few strong resident redband populations exist. Known or predicted strong areas include 17 percent of the historical range and 24 percent of the present range. Only 30 percent of the watersheds supporting spawning and rearing populations were classified as having strong populations. Resident redbands are or are predicted to be widely distributed in large blocks of suitable habitat in the Northern Cascades, Blue Mountains, and Central Idaho Mountains ERUs. These watersheds represent the core of the distribution associated with or derived from steelhead and appear to be relatively secure, although hybridization with introduced rainbow trout is a unevaluated potential threat. Populations in watersheds within the Owyhee Uplands and Northern Glaciated Mountains were isolated from steelhead in recent history by dams. These latter populations appear to be far more fragmented and probably less secure. Because these

Map 2-19. Redband Trout Distribution: Historical and Current.

latter populations are within the fringe of the range of redbands historically associated with steelhead, these populations may represent important sources of genetic diversity.

Resident–interior redband trout have few remaining strong populations; current strong populations encompass 10 percent of their historical range and 20 percent of their present range. Resident–interior redband trout occupy portions of the Northern Glaciated Mountains, Northern Great Basin, Columbia Plateau, Central Idaho Mountains, and Owyhee Uplands. These populations have been isolated from steelhead over geologic time. Resident–interior redband populations appear to have declined most in the Northern Great Basin and Columbia Plateau, where 72 percent of their historical range is presently unoccupied and there are few remaining strong populations. Remaining populations of redbands appear to be severely fragmented and restricted to small blocks of known or potential habitat. These areas likely represent a critical element of the evolutionary history for this species.

Interior redband habitats have been altered by a variety of land use practices. Reduction in streamflow because of water diversion for irrigation threatens many populations in the southern portion of the range. Increased water temperature also has been a factor, especially in drier and warmer areas. Temperature increases are largely due to loss or conversion of riparian vegetation resulting from grazing, timber harvest, urbanization, and agriculture.

There have been extensive channel alterations associated with flood-control projects, floodplain development, and road construction within the range of redbands. Channel alterations affect stream hydraulics, nutrient pathways, invertebrate production, and fish production. In Idaho, unaltered stream reaches supported eight to ten times the densities of redband trout observed in altered channels. Redband trout appear to have evolved over a broader range of environmental conditions than the other key salmonids, and appear to have less specific habitat requirements. Their apparent persistence even in some heavily disturbed basins suggests they are more resilient than other species. Therefore, the loss of a redband population could be a strong indication of disruption in the aquatic ecosystem processes.

Steelhead

Steelhead, the anadromous form of redband trout found within the project area, are distributed within the interior Columbia River Basin as two major forms, winter and summer, although interior steelhead are primarily summer-run. Winter-run steelhead enter freshwater three to four months prior to spawning, and summer-run steelhead enter freshwater nine to ten months prior to spawning.

The distribution and abundance of steelhead have declined from historical levels as a result of mortality at and between dams, habitat degradation, loss of access to historical habitat, overharvest, and interactions with hatchery-reared and exotic fishes. Most of the current populations are hatchery-reared. Numerous state and federal management agencies list remaining wild steelhead populations as species of special concern. The American Fisheries Society considers all stocks of winter steelhead upstream from Bonneville Dam to be at high or moderate risk of extinction, and most summer steelhead stocks are considered to be at moderate risk of extinction or of special concern. Within the project area three steelhead stocks are listed under the Endangered Species Act: Snake River (threatened), Middle Columbia (threatened), and Upper Columbia (endangered). Steelhead represent a key species because of their broad distribution, value as a sport fish, and importance as a tribal ceremonial and subsistence resource. Current and historical distributions of steelhead are illustrated on Map 2-20.

The historical range of steelhead includes all freshwater west of the Rocky Mountains with access to the Pacific Ocean, extending from northwest Mexico to the Alaska Peninsula. Within the project area, steelhead were historically present in most streams that were accessible to anadromous fish, occupying about 50 percent of the watersheds in the project area. This included all accessible tributaries to the Snake River downstream from Shoshone and Spokane falls and accessible tributaries to the Columbia River. In total, approximately 10,500 miles of stream were accessible to steelhead in the Columbia River Basin (including Canada), although it is unlikely that steelhead occupied all reaches of all accessible streams because water temperature may have restricted distribution. Steelhead formerly ascended the Snake River and spawned in reaches of Salmon Falls Creek, Nevada, more than 900 miles from the ocean.

Historical steelhead runs were large. It is reported that the commercial steelhead catch peaked in the late 1890s at 4.9 million pounds. Initial estimates of run sizes were derived after Bonneville Dam was constructed in 1938. In 1940, 423,000 summer steelhead passed the dam. Annual sport harvests averaged 117,000 summer-run and 62,000 winter-run fish from 1962 to 1966.

Steelhead are still the most widely distributed anadromous salmonid in the project area; however, steelhead

Map 2-20. Steelhead Distribution: Historical and Current.

are extirpated from large portions of their historical range. Presently occupied watersheds encompass approximately 45 percent of the watersheds historically occupied. Steelhead have been extirpated in the Lower Clark Fork and Owyhee Uplands ERUs. Within the Columbia River Basin in the United States and Canada, about 75 percent of the stream mileage within their historical range is no longer accessible.

Within their current distribution, few healthy wild steelhead populations exist. Some 98 percent of the watersheds where steelhead spawn and rear are classified as containing depressed populations of wild steelhead.

Within their current distribution, few healthy wild steelhead populations exist. Watersheds known or estimated to support strong spawning and rearing populations of wild steelhead represent 0.6 percent of the historical range and 1.3 percent of the current range. Some 98 percent of the watersheds where steelhead spawn and rear are classified as containing depressed populations of wild steelhead.

Existing steelhead populations are composed of four main types: wild, natural (non-native progeny spawning naturally), hatchery, and mixes of natural and hatchery fish. Production of wild anadromous fish in the Columbia River Basin has declined by about 95 percent from historical levels. Most existing steelhead production is supported by hatchery and natural fish as a result of large-scale hatchery mitigation production programs. By the late 1960s, hatchery production surpassed wild production in the Columbia River Basin. Wild fish, unaltered by hatchery stocks, are rare and are present in only 10 percent of the historical range and 25 percent of the current distribution. Core areas for remaining wild stocks are concentrated in reaches of the Salmon River in Central Idaho and the John Day River Basin in Oregon. The only remaining strong populations are found among the wild stocks, primarily in the Columbia Plateau and Blue Mountains. Within the Central Idaho Mountains, recent steelhead runs have been critically low.

Construction and operation of mainstem dams on the Columbia and Snake rivers is considered a major cause of decline of steelhead. Hydroelectric development changed Columbia and Snake river migration corridors from mostly free-flowing in 1938 to a series of impoundments by 1975, and reservoir storage activities have reduced flows in most years during smolt migration. Steelhead must navigate past as many as eight mainstem dams. Adults are delayed during upstream migrations, and smolts may be killed by turbines; become disoriented or injured, making them more susceptible to predation; or become delayed in the large impoundments behind dams. Smolt-to-adult return rates declined from approximately 4 percent in 1968 to less than 1.5 percent from 1970 to 1974. In 1973 and 1977, low flows resulted in 95 percent mortality of migrating smolts. Since the initial operation of the hydrosystem several modifications, such as screen flow requirements, have been made in an attempt to improve migrant survival. Map 2-13 (earlier in this section) illustrates the locations of mainstem dams on the Columbia River System.

Non-native fish and hatchery operations have also affected wild steelhead populations. Hatcheries have been widely used in attempts to mitigate losses of steelhead caused by construction and operation of dams. Hatchery operations affect wild steelhead populations through genetic hybridization and loss of fitness, creation of mixed-stock fisheries, competition for food and space, and increased incidences of diseases. Introduced rainbow trout also have the potential to mature and hybridize with steelhead, and this species has been introduced throughout the current steelhead range. Supplementation of native stocks with hatchery fish have typically resulted in replacement, not enhancement, of native steelhead.

Biotic factors including predation and competition also may influence the abundance of steelhead. More than 55 exotic fish species have been introduced within the current range of steelhead. Because exotic fish species did not co-evolve with steelhead, there has been no opportunity for natural selection to lessen competition or predation. Dams have created habitat that is suitable for a variety of native (such as northern squawfish) and non-native predators and potential competitors. The abundance and distribution of native predators may also be influenced by human habitat alterations.
More than 95 percent of healthy native anadromous fish stocks are believed to be threatened by some degree of habitat degradation. Fish habitat quality in most watersheds has declined. As described earlier in this chapter, pool frequency has decreased and fine sediment has increased in many project-area watersheds. In addition to hydroelectric development, most alterations of steelhead habitat can be attributed to land-disturbing activities as a result of mining, timber harvest, livestock grazing, agriculture, industrial development, and urbanization.

Chinook Salmon

Chinook salmon in the project area are traditionally described as spring, summer, and fall runs, distinguished primarily by their time of passage over

Bonneville Dam. These names have led to some confusion because stocks of similar run timing may differ considerably between the Snake and Columbia rivers in their spawning areas, life histories, behavior, and genetic characteristics. For the purposes of the Broadscale Assessment of Aquatic Species and Habitats (Lee et al. 1997), chinook salmon that migrate seaward as yearlings are called "stream-type" and those that migrate as subyearlings are called "ocean-type." Snake River chinook salmon (stream- and ocean- types; threatened) and Upper Columbia chinook salmon (stream-type; endangered) are listed under the Endangered Species Act. Current and historical distributions of chinook salmon are illustrated on Map 2-21.

The historical range of chinook salmon in North America was the eastern Pacific and Arctic oceans and accessible freshwater. Like steelhead, chinook salmon were found in all accessible areas of the Snake River downstream from Shoshone Falls, and they formerly ascended and spawned in reaches of Salmon Falls Creek, Nevada, more than 900 miles from the ocean. Approximately 10,500 miles of stream were accessible to chinook salmon in the Columbia River Basin in the United States and Canada.

Stream-type chinook salmon were widely distributed, occupying about 45 percent of the watersheds in the project area, and occurring in all areas except the Northern Great Basin, Upper Clark Fork, Snake Headwaters, and Upper Snake above Shoshone Falls. Within accessible watersheds, chinook salmon distribution may have been restricted by unsuitable water temperatures at high elevations and the need for relatively large areas of suitable spawning gravel. Chinook salmon juveniles also prefer low gradient, meandering stream channels, which may have further restricted their distribution.

Historical runs of chinook salmon were immense; estimates of annual runs sizes prior to 1850 range from 3.4 to 6.4 million fish. Most American Indians in the project area shared a major dependence on salmon as a subsistence and ceremonial resource. Commercial harvest of chinook salmon in the mainstem Columbia River peaked in 1883 at 2.3 million fish, and the average annual yield was approximately 1.3 million fish from 1890 to 1920.

Chinook salmon are presently the most endangered of the key salmonids, with populations lost in large portions of their historical range. Construction of Grand Coulee Dam in the early 1940s and the Hells Canyon Dam complex in 1967 eliminated chinook salmon from much of their former ranges within the Upper Columbia and Snake river drainages. In total, about 75 percent of historically accessible streams are no longer accessible to chinook, primarily because of dam blockages. Current known and estimated distributions of stream-type chinook salmon include 28 percent of their historical ranges. Stream-type chinook are extirpated in all of the Lower Clark Fork and Owyhee Uplands and in large portions of other ecological reporting units that currently support populations. In the Snake River, an estimated 1,882 naturally produced stream-type chinook salmon reached Lower Granite Dam in 1994 as compared to an estimated production of 1.5 million fish in the late 1880s.

About 75 percent of historically accessible streams are no longer accessible to chinook

Most chinook salmon stocks in the remaining accessible range are severely depressed and at risk. For stream-type chinook salmon, watersheds known or estimated to support strong spawning and rearing populations represent 0.2 percent of the historical range and 0.8 percent of the current range; approximately 99 percent of the current stream-type chinook spawning and rearing populations are classified as depressed. The only remaining strong populations appear to be restricted to small areas of the John Day River Basin in the Blue Mountains. Within the Central Idaho Mountains, recent runs of stream-type chinook salmon have been critically low, and most populations are believed to be on the brink of extinction. Construction and operation of mainstem dams on the Columbia, Snake, and Klamath rivers is considered a cause of decline of chinook salmon (Map 2-13, earlier in this section). Besides reducing accessible habitat, hydroelectric development changed Columbia and Snake river migration corridors from mostly free-flowing in 1938 to a series of impoundments by 1975, and reservoir storage activities have reduced flows in most years during smolt migration. Like steelhead, chinook adults are delayed during upstream migrations, and smolts may be killed by turbines; become disoriented or injured, making them more susceptible to predation; or become delayed in the large impoundments behind dams. Development and operation of hydropower facilities in the Columbia River Basin has reduced salmon and steelhead production by about eight million fish: four million from blocked access to habitat above Chief Joseph and Hells Canyon dams, and four million from ongoing passage losses at other facilities. Passage losses are cumulative depending on the number of dams; chinook salmon in the project area must pass one to nine dams. Losses of mid and upper Columbia ocean-type chinook salmon were estimated to be approximately 5 percent per dam for adults and 18 to 23 percent per dam for juveniles.

Map 2-21. Stream-Type Chinook Salmon Distribution: Historical and Current.

Like steelhead, many remaining chinook salmon populations have been influenced by hatchery-reared fish. Production of wild anadromous fish in the Columbia River Basin has declined by approximately 95 percent from historical levels. As a result, wild populations unaltered by hatchery stocks are rare; they are present in 4 percent of the historical range and 15 percent of the current range of stream-type chinook salmon. Only those watersheds in the project area containing spawning and rearing populations sustained by wild stocks are classified as strong.

The overall pattern of decline of chinook salmon suggests the species is sensitive to habitat degradation throughout its entire range. Excessive livestock grazing pressure, timber harvest, and irrigation diversions have been important factors. Reduced stream habitat diversity has been one of the most pervasive cumulative effects of forest management practices and may have altered fish communities. Forest management practices, including timber harvest activities, have reduced salmon habitat quantity and diversity, reduced habitat complexity, increased sedimentation, and eliminated sources of woody debris needed for healthy salmon habitat. In the Snake River Basin, more than 80 percent of the salmon production occurs on Forest Service- and BLM-administered lands. In portions of the Snake River Basin still accessible to salmon, management history on Forest Service-administered lands has reduced the suitability of approximately 1,930 miles of stream.

Predation is one of the major causes of mortality to juvenile chinook salmon. Exotic species may prey upon and compete with native fishes. Many of the middle and lower reaches of the Columbia River are dominated by exotic fish species. Northern squawfish, a native predator, has become well adapted to the habitat created by dams. It has been estimated that 15 to 20 million juvenile salmonids in the Snake and lower Columbia rivers are lost to northern squawfish predation.

Native Species Richness, and Biotic and Genetic Integrity

The information presented in this section was used to determine the A1/A2 subwatershed boundaries and aquatic restoration priorities described in Chapter 3.

The specific conditions regarding fish species and groups of fishes that are outlined in preceding sections can be integrated in various ways to provide an overall picture of aquatic conditions in the project area. Some key attributes include native species richness (number of species), and genetic and biological integrity. This information can help prioritize management actions through watershed categorization or designation of important watersheds. Key (or priority) watersheds have been identified under various Biological Opinions for federally listed fish species and other native fish recovery plans. For the Draft EISs, the Science Integration Team developed subbasin categories that summarize current aquatic conditions, especially with regard to management opportunities and priorities.

Species Richness

The number of native fish species (species richness) present in a watershed is an important element of biodiversity. A high degree of overlap in species are characteristic of strong habitat diversity. Even considering a fairly narrow group of species such as the salmonids, each species relies on different habitats and environments. The occurrence of several salmonids indicates suitable habitats over relatively large landscapes. High richness may also indicate critical habitats that serve as common corridors, wintering areas, or seasonal refuges for varied life histories. The largest remaining regions of high species overlap considering all native fish species are associated with the Central Idaho Mountains, Blue Mountains, Northern Cascades, and their connecting river corridors.

Overlap of strong populations for multiple native salmonids indicates areas of high species richness that have not yet experienced extensive declines in fish populations. Presently within the project area, less than 0.01 percent of the subwatersheds concurrently support three strong salmonid populations, 3 percent support two strong populations, and approximately 20 percent support one strong population. The largest block of contiguous or clustered subwatersheds supporting strong populations is within subbasins in the Central Idaho Mountains, Blue Mountains, and Snake Headwaters ERUs. Smaller blocks are found in the Upper Clark Fork and the extreme eastern fringe of the Northern Glaciated Mountains ERUs. Most of the watersheds supporting strong populations are found on Forest Service-administered lands (75 percent), and some (29 percent) are located within protected areas represented by designated wilderness areas or national parks. Subwatersheds with multiple strong populations are more commonly under Forest Service management than other ownerships. Map 2-23 illustrates the current known and estimated key salmonid strongholds in the project area.

Map 2-23. Salmonid Strongholds.

Biotic Integrity

The concept of biotic integrity has been proposed to evaluate the loss of natural diversity and to define those remaining portions of the landscape that could be most valuable in maintaining or closely approximating historical levels of natural diversity. Biotic integrity has been generally defined as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1991 as cited in Lee et al. 1997). Integrity specifically refers to native biota that reflect natural evolutionary and biogeographic processes. Several measures of biotic integrity have been developed, often reflecting different attributes for communities of invertebrates and amphibians as well as fish (Fisher 1989; Lyons et al. 1995 as cited in Lee et al. 1997).

Because project-wide information was limited to fish in the *Scientific Assessment*, a relatively simple measure of integrity was developed reflecting the diversity and structure of the native fish community at both the life-history and species levels of organization (Lee et al. 1997). The highest concentration of high integrity values was found in the Northern and Southern Cascades, Blue Mountains, Central Idaho Mountains, and the southern edge of the Columbia Plateau. Smaller blocks of high values were also found in the Lower Clark Fork. One readily apparent trend is that many of the high-value integrity areas are found in forested areas within the range of anadromous fish. Rangeland and agricultural areas tended to have lower integrity values.

Genetic Integrity

Hatchery programs may erode genetic diversity and alter certain gene complexes that evolved together and are characteristic of locally adapted stocks of salmonids. The effects may include a loss of fitness or performance (growth, survival, and reproduction) and a loss of genetic variability important to long-term stability and adaptation in varying environments. The analysis of genetic integrity is incomplete and would require a finer level of analysis for a consistent application to resident salmonids, but in general the areas important to the genetic integrity of the anadromous salmonids are found principally within the Blue Mountains and Central Idaho Mountains ERUs, where hatchery fish have had little or no influence on current populations.

Fringe Environments

'Fringe' environments are those at the extreme edges of a species distribution. Fringes may support a disproportionately large part of the genetic diversity within a species because of the genetic adaption needed to survive in a variable environment. Populations that represent native gene complexes and the widest possible diversity probably offer the best resources for reestablishing extinct populations in similar environments. They are also important for sustaining the most important components of overall genetic diversity characteristic of these species.

The fringe of the range for westslope cutthroat trout is in the Blue Mountains. Watersheds within the Columbia Plateau technically qualify as part of the westslope cutthroat fringe distribution, but those watersheds are really part of a much larger distribution of cutthroat in the upper portions of that basin. For that reason the Columbia Plateau was not included as part of the fringe for westslope cutthroat trout. The fringe defined for bull trout includes the Southern Cascades, the Upper Klamath, the Owyhee Uplands, and the Walla Walla and Umatilla drainages within the Columbia Plateau.

The Upper Klamath, Northern Cascades, and Owyhee Uplands are recognized as fringe areas in the remaining distribution of resident-interior redband trout. No watersheds are considered to represent a fringe for Yellowstone cutthroat trout or resident redband trout. Any further loss of current distributions within the Upper Snake or Upper Klamath Basin would make these areas of concern, however. The Northern Glaciated Mountains was identified in the *Scientific Assessment* as the fringe for steelhead. Population declines within the Southern Cascades could make that area important for steelhead as well. The Southern Cascades and Northern Glaciated Mountains are important for stream-type chinook salmon. The distribution of ocean-type chinook salmon within the project area is so restricted that all of the remaining distribution qualifies as part of the fringe.

Subbasin Categories

The subbasin categories were used in the development of aquatic restoration priorities. To assist with an ecosystem approach to the management of watersheds and aquatic resources, the Science Integration Team developed a simple classification of subbasins

The Effects of Hydropower, Hatcheries, Harvest, and Habitat on Interior Columbia River Anadromous Fishes

Anadromous fishes are the focus of this sidebar because of their current scarcity resulting from influences of hydropower, hatcheries, harvest, and habitat. These four activities, which affect or limit the survival of anadromous fishes, have been broadly grouped as the *ALL Hs* (*Idaho Department of Fish and Game et al. vs. NMFS et al.*1994). Because of the cumulative effect of the *ALL Hs,* several salmon and steelhead stocks within the project area have been listed as endangered or threatened pursuant to the Endangered Species Act (ESA).

In public scoping and comments on the ICBEMP Draft EISs, an important question surfaced about how hydropower, harvest, and hatcheries (factors outside the land management agencies' jurisdictions), would be considered in the development of alternative Forest Service and BLM land management strategies that affect anadromous fish habitat. The Executive Steering Committee for the ICBEMP directed that the project specifically address the following:

1. What are the relative contributions of habitat, hydropower, hatcheries, and harvest on the current state of populations within the interior Columbia River Basin?
2. If all other factors were held constant, would a further degradation of habitat increase the risks of extirpation or extinction?
3. If all other factors were held constant, would an improvement in freshwater habitat conditions increase fish abundance and reduce the risks of extirpation or extinction?
4. If nothing is done to restore habitat, and if mitigation of major factors such as dams is successful, would there be sufficient habitat available to accommodate increasing fish numbers?

Forest Service- and BLM-administered habitat for anadromous fish is also important for numerous other aquatic and riparian resources and human uses, including: native trout, amphibians, recreation, and clean water. Alternative land management strategies will consider these important resource values in addition to the anadromous fish issues discussed below.

This summary, based on a Science Integration Team report (Lee and Rieman 1996) and other relevant sources cited in the text, responds to the above four questions. It provides an overview of the effects of habitat, harvest, hydropower and hatcheries on interior Columbia River Basin anadromous fishes. It does not apply to resident native fish such as bull trout and cutthroat trout, which do not migrate to and from the ocean. The information is generally applicable to spring/summer and fall chinook, sockeye, and steelhead in the interior Columbia River Basin.

1. **What are the relative contributions of habitat, hydropower, hatcheries, and harvest on the current state of populations within the interior Columbia River Basin?**

Hydroelectric development is generally regarded as a major factor in the decline of anadromous populations, irrespective of changes in freshwater habitat (Northwest Power Planning Council 1986, in Lee and Rieman 1996; Raymond 1988, in Lee and Rieman 1996). Explicit recognition of the role of hydroelectric development contributed to passage of the Northwest Power Planning and Conservation Act of 1980, and to development of the Northwest Power Planning Council's Fish and Wildlife Program, a regional effort to simultaneously address the four principal factors affecting anadromous fish.

Habitat is a major factor in supporting anadromous fish populations. The information provided by the broad-scale assessment of aquatic habitats and species within the interior Columbia River Basin (Lee et al. 1997) lends support to a scientifically credible view that is emphasized repeatedly in the literature: habitat change is pervasive and at times dramatic, but impacts are not evenly distributed across the landscape. For instance, there are remaining high-quality areas, generally associated with wilderness or other protected areas, that are capable of supporting anadromous fishes at near historical levels in these areas. In many other areas habitat has been degraded and survival of the freshwater life stages has been compromised. To support recovery of populations of anadromous fish, it will be necessary to expand and reconnect areas of high quality habitat. Restoration of depressed populations cannot rely on habitat improvement alone, but requires a concerted effort to address causes of mortality in all life stages. These include freshwater spawning, rearing, juvenile migration, ocean survival, and adult migration.

The question of relative contributions of the *ALL Hs* to anadromous fish mortality cannot be answered precisely. Simultaneous changes in a variety of factors, combined with the lack of historical data, prevents estimation of the proportionate influence of each factor across the entire basin. It is expected that the contribution of freshwater habitat changes to declines in anadromous fish populations is least in the less disturbed areas of central Idaho (such as in wildernesses or other protected areas), where there are the most dams between spawning and rearing areas and the ocean, and in the northern Cascades, but greater in the lower Snake and mid-Columbia drainages. Similarly, the contribution of hydropower to fish mortality declines downriver where there are fewer dams between freshwater spawning and rearing areas and the ocean (Lee et al. 1997). Hatcheries are an important element throughout the basin, but their effects on native stocks are quite variable. Harvest, which has been curtailed in recent years, has less of an effect today than it did historically. In some subbasins such as the Umatilla, irrigation withdrawals may be the major contributor to declines in naturally reproducing populations.

2. **If all other factors were held constant, would a further degradation of habitat increase the risks of extirpation or extinction?**

Yes, regardless of the contributions of other factors, spawning and juvenile rearing habitat remain an important component in the viability equation. Freshwater habitat can be most important in ensuring viability of stocks that are depressed through a combination of other factors.

3. **If all other factors were held constant, would an improvement in freshwater habitat conditions increase fish abundance and reduce the risks of extirpation or extinction?**

Yes, although the magnitude of the effect would vary greatly from subbasin to subbasin. In areas where present habitat is degraded and hydropower effects are smaller, such as the John Day and Deschutes rivers, habitat improvements could result in immediate increases in numbers of fish. In areas where habitat is degraded and hydropower effects are large, such as in the Grand Ronde River and some tributaries of the Salmon River (for example, Panther Creek), increases in population numbers due to habitat restoration would be more modest and gradual. In other areas where there is abundant high-quality habitat but few adult spawners, such as in the Middle Fork Salmon River, immediate increases in fish abundance would not be expected. One aspect of habitat improvement that could have long-term repercussions, if not immediate benefits, is that increased availability of high-quality habitats reduces the chances that a random, catastrophic event such as a large fire followed by flooding would wipe out all of the best available habitat. A wider distribution of high-quality habitats also improves the likelihood of increased genetic diversity, an additional benefit over the long term. In general, while additional high quality habitat alone could increase the abundance of individual fish, it would not likely reverse current negative population trends in the short term.

4. **If nothing is done to restore habitat, and if mitigation of major factors such as dams is successful, would there be sufficient habitat available to accommodate increasing fish numbers?**

The answer varies across the basin. Population numbers in much of the interior Columbia River Basin are far below what current habitat conditions could likely support under a scenario of increased downriver survival. Some remote areas (for example central Idaho and northern Cascades) potentially could support hundred-fold increases or better in the number of adult fish, but this is not the case everywhere. There are disturbed areas where increased adult numbers would lead to compensatory declines in freshwater survival rates, thus reducing the per capita productivity of the population and limiting the effectiveness of downstream improvement efforts. If the objective is to fully realize the benefits of downstream improvements, then commensurate increases over current availability and distribution of high-quality habitat will be necessary.

throughout the Interior Columbia Basin Ecosystem Management Project area (Lee et al. 1997). Subbasins were used as the primary classification unit because they commonly approximate complete aquatic ecosystems, supporting most of the life-history diversity expected over larger river basins (see the Introduction to this chapter for an explanation of subbasins and 4th-field Hydrologic Unit Codes). Three broad categories of subbasin condition (as it relates to aquatic ecosystems) have been defined, recognizing that a continuum of conditions exists. Subbasins were categorized along a gradient of conditions relative to highly functional aquatic ecosystems. Highly functional systems were defined as subbasins with a full complement of native fishes and other aquatic species, and well distributed and connected high quality habitats. The classification is based on the integration of current data as well as local knowledge of watershed connectivity and condition that is not expressed quantitatively. Subbasin categories developed by the Science Integration Team are illustrated in Lee et al. 1997, Map 4.74, and in the ICBEMP Draft EISs, Map 2-25 (UCRB) or Map 2-36 (Eastside).

The categorization is intended to set the stage for a broad-scale analysis of management needs and opportunities that can focus the need for finer-scale analysis. It is intended to facilitate the discussion of management opportunity and conflict by providing a description of aquatic issues and needs that could be associated with similar descriptions for terrestrial ecosystems. It is not intended to be all inclusive, final, or inflexible.

Category 1 Subbasins

Category 1 subbasins most closely resemble natural, fully functioning aquatic ecosystems. In general they support large, often continuous blocks of high-quality habitat and watersheds with strong populations of multiple species. Connectivity is unimpeded among watersheds and through the mainstream river corridor. All life histories, including migratory forms, are present and important. Native species predominate, although introduced species may be present. These subbasins provide a system of large, well-dispersed habitats that are resilient to large-scale disturbances. They provide the best opportunity for long-term persistence of native aquatic assemblages and may be important sources of individuals that could recolonize other areas.

Category 2 Subbasins

Category 2 subbasins support important aquatic resources and often have subwatersheds classified as strongholds for one or more species scattered throughout. The integrity of the fish assemblage is high or moderate. The most important difference between Category 1 and Category 2 subbasins is increased fragmentation in Category 2 that has resulted from habitat disruption or loss. These subbasins have numerous watersheds where native species have been lost or are at risk. Connectivity among watersheds exists through the mainstream river system, or has the potential for restoration of life-history patterns and dispersal among watersheds. Because these subbasins commonly fall in some of the more intensively managed landscapes, they may have extensive road networks. Stronghold subwatersheds are scattered rather than contiguous. These subbasins are more likely to have aquatic and hydrologic restoration opportunities through active manipulation, or through attempts to produce more episodic disturbance followed by long periods of recovery.

Category 3 Subbasins

Category 3 subbasins may support populations of key salmonids or have other important aquatic values, such as threatened or endangered species, narrow endemics, and / or introduced or hatchery-supported sport fisheries. In general, however, these watersheds are strongly fragmented by extensive habitat loss or disruption throughout the component watersheds, and most notably through disruption of the mainstream corridor. Major portions of these subbasins are often associated with private and agricultural lands not managed by the Forest Service or BLM. Although important and unique aquatic resources exist, they are usually localized. Opportunities for restoring connectivity among watersheds, full expression of life histories, or other large-scale characteristics of fully functioning and resilient aquatic ecosystems are limited or nonexistent in the near future. Because the remaining aquatic resources are often strongly isolated, risks of local extinction may be high. Conservation of the remaining productive areas may require a disproportionate contribution from federal management agencies, because these subbasins often include large areas of non-federal land.