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Viability Assessments and Management Considerations for Species Associated With Late-Successional and Old-Growth Forests of the Pacific Northwest

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INTRODUCTION

Many fish stocks of anadromous salmonids (*Oncorhynchus* spp.) are presently in questionable conditions. (A stock is a locally adapted population that is reproductively isolated from other stocks [Ricker 1972]). The Endangered Species Committee of the American Fisheries Society recently identified 214 fish stocks in California, Oregon, Washington, and Idaho that are in need of special management considerations because of low or declining numbers (Nehlsen et al. 1991). Another, the Illinois River winter steelhead trout (*O. mykiss*), is being considered for threatened and endangered status. Another 101 were believed to face a high risk of extinction and 58 a moderate risk. An additional 106 fish stocks are believed to already be extinct (Nehlsen et al. 1991). To date, 4 have been listed as threatened and endangered. Figure 5-K-1 shows the distribution and status of these fish stocks in the area of the northern spotted owl. One, the Sacramento River winter chinook salmon (*Oncorhynchus tshawytscha*), has been listed under the Endangered Species Act. Higgins et al. (1992) and USDI (1992) also identified stocks of anadromous salmonids that were in danger of extinction. These fish stocks are primarily subsets of those identified by Nehlsen et al. (1991). For this report, we only considered fish stocks identified by Nehlsen et al. (1991).

Primary factors contributing to the decline of anadromous salmonid stocks include: (1) degradation and loss of freshwater and estuarine habitats due to urbanization, agriculture, livestock grazing, mining, timber harvest, and dams; (2) over-exploitation in commercial and recreational fisheries; (3) migratory impediments such as dams; and (4) loss of genetic integrity due to the effects of hatchery practices and introduction of non-local stocks (Nehlsen et al. 1991). Often two or more of these factors operating in concert are responsible for a decline in fish stock numbers.

The status of anadromous fish stocks in northern California, Oregon, and Washington reflects the condition of fish throughout North America. Williams et al. (1989) listed 364 species and subspecies of fish in North America that are in need of special management considerations because of low population numbers. This is an increase of 139 species since 1979. No species were removed from the list as a result of successful recovery programs. Allendorf (1988) reported that a large proportion of the freshwater fish fauna in western North America is in precarious condition and in need of special attention. He noted that the potential rates of loss of biodiversity rival those observed in the tropics. Moyle and Williams (1990) found that 57 percent of the native freshwater fish of California were extinct or in need of immediate action. The condition of these fish is attributable to the same suite of factors that are responsible for the state of anadromous salmonid stocks (Williams et al. 1989, Moyle and Williams 1990).

Loss and degradation of freshwater habitats are the most frequent factors responsible for the decline of anadromous salmonids stocks (Nehlsen et al. 1991). This includes decreases in the quantity and quality of habitat and the fragmentation of habitat into isolated patches. These changes have resulted from an array of human activities including urbanization, agricultural activities, timber harvest and associated activities, livestock grazing, water withdrawal and diversion, and dams (Nehlsen et al. 1991). In the region of the northern spotted owl the first three are the activities that are primarily responsible for the loss or decrease in the quality of fish habitat. On lands within the range of the northern spotted owl managed by the Forest Service, the primary land management activities affecting fish habitat are timber harvest and associated activities, and some grazing.

Freshwater habitat may be disproportionately more important for the survival and persistence of anadromous salmonid stocks found in the range of the northern spotted owl than it would be for species and fish stocks found in more northerly areas. All anadromous salmonids spend a portion of their life cycle in freshwater. Adults return from the ocean to reproduce. Early life history stages (i.e., eggs, alevins, fry and juveniles) also occur in freshwater. Duration of freshwater residence ranges from a few days or weeks to 2 or more years depending on species and fish stocks.

Ocean conditions for anadromous salmonids in the range of the northern spotted owl are highly variable. The oceanic boundary between cool, nutrient rich northern currents and warm, nutrient poor southern currents often occur off the coast of northern California, Oregon and Washington (Bottom et al. 1986). Favorable conditions exist when the boundary is more southerly, which has occurred on average of 1 in 4 years in the last 40 years (Bottom et al. 1986). During favorable ocean conditions, survival of at least some fish stocks is greater than during less favorable conditions (Nickelson 1986).

Additionally, the coast in this region has a low shoreline/coastline ratio (Bottom et al. 1986). The consequence of this is that there are few well developed estuaries and other nearshore rearing areas. These areas are sites of early growth in the ocean, which is important for survival in the marine environment (Hager and Noble 1976, Bilton et al. 1982, Ward et al. 1989, Henderson and Cass 1991, Pearcy 1992). This is particularly important during times of unfavorable ocean conditions. In much of the region of the northern spotted owl, fish moving to the ocean do not have nearshore areas in which to grow. In contrast, British Columbia and southeast Alaska have higher shoreline/coastline ratios and thus more and better nearshore habitats. Because of the scarcity of nearshore habitats and the variable ocean conditions, the existence of adequate quantities and qualities of freshwater habitat is more critical for the survival and persistence of fish stocks in the range of the northern spotted owl than it is for fish stocks in more northerly areas. Compared to fish in areas with more stable ocean conditions and better developed nearshore habitats, fish in the region of the northern spotted owl are more dependent on freshwater environments to achieve larger sizes, which increase probability of marine survival.

CHARACTERISTICS OF FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

Characteristics of High Quality Fish Habitat Conditions

Assemblages of anadromous salmonids associated with forests within the range of the northern spotted owl include five species of Pacific salmon and two species of trout (Table 5-K-1). Each species has a variable number of discreet fish stocks that are genetically isolated from each other and specifically adapted to local habitat characteristics. It is quite common for several species and numerous fish stocks to coexist in the same sections of stream systems throughout their range. As a result, the anadromous salmonid assemblage of most stream systems is a complex mixture of several species and stocks. Each species and fish stock has exacting but different habitat requirements (see Bjornn and Reiser 1991), requiring diverse and complex habitats to maintain populations of all groups.

The life history of anadromous salmonids adds to the complexity of freshwater habitat needs. All anadromous salmonids spawn in freshwater. Juvenile fish rear in streams and lakes for variable periods of time before moving to the ocean where they grow to adulthood (see Meehan and Bjornn 1991, Groot and Margolis 1991). Some species reside in freshwater for only a few weeks (e.g., pink and chum salmon), but more commonly, juveniles reside in freshwater for one to several years (e.g., coho salmon and cutthroat trout), growing to 8 inches or more in size before entering the ocean. Habitat needs are different for each species, age class and size class of juvenile fish, and for each season of the year (Bjornn and Reiser 1991, Groot and Margolis 1991). Therefore, freshwater habitats must provide good water quality and quantity, as well as numerous substrate and habitat types, cover, and food resources to accommodate the habitat needs of mixed anadromous salmonid assemblages.

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

The following characteristics of productive natural habitats for anadromous salmonids apply to 3rd- to 5th-order streams (Strahler 1957) which may support a mixed species assemblage of juvenile anadromous salmonids. (Streams of these orders are generally 15-50 feet wide and are typical of streams managed by the Forest Service within the range of the northern spotted owl.) Not all of the desired features are expected to occur in a specific reach of stream, but they generally will occur throughout a productive watershed. Factors such as climate and geology can exert strong influences on productivity of streams and influence fish habitat. Although these are beyond human control (Naiman et al. 1992), their effects must be considered in any management decisions.

Water Quality - All salmonids require high quality water for spawning, rearing, and migration (Bjornn and Reiser 1991). An abundance of cool (generally <68°F), well oxygenated water, free of excessive amounts of suspended sediments (Sullivan et al. 1987) and other pollutants is required at all times of the year. Water temperatures must be within the range that synchronize the time of migration and emergence of fish and other aquatic organisms (Sweeney and Vannote 1978, Quinn and Tallman 1987).

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

Channel Characteristics - The most productive stream systems for mixed salmonid assemblages have gradients <5 percent. They are comprised of constrained (i.e., ratio of valley width/active channel width <3) and unconstrained (i.e., ratio of valley width/active channel width >3) reaches, which contain a broad diversity and complexity of habitat features. Constrained reaches generally have fewer juvenile fish and less diverse assemblages than unconstrained areas. Constrained reaches are important, however, as sources of cool water (McSwain 1987), holding areas for adult salmonids, and are avenues of transport for sediment, wood, and other materials to unconstrained reaches (Naiman et al. 1992).

Unconstrained reaches are generally sites of high fish densities. They are also sites of sediment, organic material, and nutrient storage and processing (Stanford and Ward 1988). High quality habitats maintain a balance between high quality pools, riffles, glides, and side channels. Cover features such as large woody debris, boulders, undercut banks, overhanging vegetation, deep water, and surface turbulence are abundant in high quality habitats. Substrates consist of a variety of particle sizes ranging from silts to boulders to accommodate the spawning and rearing needs of all species (Everest et al. 1987, Sullivan et al. 1987). Spawning gravels contain low percentages of fine sediments, generally <20 percent (see Bjornn and Reiser 1991). Channels are free of obstructions that may interfere with the upstream or downstream migration of adult or juvenile salmonids.

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

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

The wide range of natural variation of individual factors and the complex interplay between stream habitat variables (e.g., numbers of pools and pieces of large wood, percent fine sediment, and water temperature) make it difficult to quantitatively establish levels for habitat features.

It is also difficult to quantify direct linkages among processes and functions outside the stream channel to in-channel conditions and biological variables.

Stream habitat variables should not be used as management goals in and of themselves. No target management or threshold level for these habitat variables can be uniformly applied to all streams. While this approach is appealing in its simplicity, it does not allow for natural variation among streams (Gregory et al. 1991; Rosgen 1988; and Ralph et al. unpub.). These habitat parameters must be viewed collectively as part of the larger issue of watershed health and maintenance of natural physical and biological integrity (Karr 1991; Naiman et al. 1992).

Current Conditions of Fish Habitat

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

The number of large, deep pools (i.e., >6 ft deep and >50 yd.^{2} surface areas) in many tributaries of the Columbia River have decreased in the past 50 years (Sedell and Everest 1991). This was determined by comparing quantitative habitat surveys done recently with surveys done by the Bureau of Fisheries, now the National Marine Fisheries Service, between 1934 and 1941 (Rich 1948, Bryant 1949, Bryant and Parkhurst 1950, Parkhurst 1950a-c, Parkhurst et al. 1950). The Bureau of Fisheries surveys are unique because they are the only long-term data set that quantifies fish habitat in a way that is replicable over time. In the Washington and Oregon Cascade Mountains, the historical surveys were generally in late-successional Douglas-fir forests that had not been extensively roaded and harvested.

Overall, there has been a 58 percent reduction in the number of large, deep pools in resurveyed streams in National Forests within the range of the northern spotted owl in western and eastern Washington (Table 5-K-2). A similar trend was found in streams on private lands in coastal Oregon where large, deep pools decreased by 80 percent (Table 5-K-2). Primary reasons for the loss of pools are filling by sediments (Megahan 1982), loss of pool forming structures such as boulders and large wood (Bryant 1980, Sullivan et al. 1987), and loss of channel sinuosity by channelization (Furniss et al. 1991, and Benner 1992).

The Wind River in the Gifford Pinchot National Forest in Washington was the exception to the trend. Large, deep pools increased between 1937 and 1992 (Table 5-K-2). The upper western portion of the Wind River burned in the 1910's during the Yacolt Burn. Its channels were also cleared and used for log drives. Recovery has been a result of Forest Service restoration efforts and the flood of 1964, which probably helped to return large wood and boulders into the upper tributaries of the Wind River basin.

Ralph et al. (unpub.) reported the loss of pools in streams in basins with moderate levels of timber harvest (i.e., <50 percent of the basin harvested in the last 40 years) to intensive levels of timber harvest (i.e., >50 percent of the basin harvested within the last 40 years and a road density of >5.3 miles per mile^2) in western Washington. Habitat features in stream segments draining basins with old-growth forests were compared to those in streams in basins with moderate and intensive timber harvest levels. In streams in basins with moderate harvest levels, the percent of the area of pools and pool depth was less than that found in the streams draining old-growth forests. Pools >3 feet in depth were greatly reduced in the intensively harvested basins compared to those containing old growth. Bisson and Sedell (1984) reported similar results for other streams in western Washington. Such changes in habitat can result in a decrease in the diversity of the salmonid assemblage (Bisson and Sedell 1984; Reeves et al., in press).

The South Fork Umpqua River, in the Umpqua National Forest, was surveyed in 1937 by the Bureau of Commercial Fisheries on contract to the Forest Service. In 1990, seven tributaries were resurveyed by the Forest Service (J. Dose, Umpqua National Forest). In the area of two of these streams, Quartz and Castle Rock Creeks, there has been only a small amount of roading and logging and these streams serve as "controls" for evaluating changes in habitat conditions. The areas of the other five streams have been roaded and extensively logged, beginning in the early 1960's. Stream widths have increased 50 to 110 percent in the intensively logged areas. Width of one control stream decreased, while in the other it increased by 13 percent. Stream temperatures were taken on Quartz Creek and four of the five streams on various dates in July and August, 1937. All of the streams had temperatures below 65°F at that time. From 1980 to 1990, Quartz Creek, one of the controls, still exhibited a summer maximum water temperature regime below 65°F during the period July 1 to August 20. (Temperature data were not available from the other control, Castle Rock Creek.) Maximum water temperature in streams of four of the five logged areas when measured over the same 60-day summer period for the last 10 years, exceeded 65°F from 62 to 93 percent of the time. (Temperatures were not available from the fifth stream.) Numbers of pieces of large wood (>36" diameter and 50' long) reflect the same trends: much higher amount in the control streams than those in areas that have been roaded and harvested.

Causes and Implications of Habitat Degradation

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

Despite the lack of strong quantitative relationships between forest management activities (and other activities as well), a primary consequence of these activities has been the simplification of fish habitat (Hicks et al. 1991, Bisson et al. 1992). Simplification of stream channels involves a decrease in the range and variability of stream flow velocities and depths (Kaufmann 1987), reductions in the amount of large wood and other structural elements (Bisson et al. 1987, Bilby and Ward 1991), elimination of physical and biological interactions between a stream and its floodplain (Naiman et al. 1992), and a decrease in the frequency and diversity of habitat types and substrates (Sullivan et al. 1987). Salo and Cundy (1987) and Meehan (1991) contain additional references detailing the link between effects of land management activities and the condition of fish habitat. The consequence of these changes has been a reduction in the diversity and quality of habitats available to fish.

A conference of management agencies and interested individuals and groups was convened recently by the Governor of Oregon (Oregon Governor's Coastal Salmonid Restoration Initiative, Newport, Oregon, 15-17 December 1992). For this conference, a panel of biologists from state and Federal agencies, universities, and private industries was asked to assess the degree to which various factors limit production of the wild species and stocks of anadromous salmonids in coastal Oregon (coho, chinook, and chum salmon; steelhead and sea-run cutthroat trout). The evaluation of factors limiting production of the wild species and stocks of anadromous salmonids in coastal Oregon which were presented at the Governor's conference is the most extensive and detailed current evaluation in the coastal forests with spotted owls. Although it was a subjective assessment, it drew upon the expertise and judgement of numerous resource specialists, scientists, and fisheries managers. The intent was to provide the basis needed to develop programs to protect and restore the production of these fish.

Results of the assessment of limiting natural production for freshwater components, spawning and rearing habitat, are shown in Table 5-K-3. Spawning gravel quantity and quality were rated as having a high potential for limiting production of chum salmon and fall and spring chinook (Table 5-K-3). Gravel quality was believed to be poor because it was unstable (i.e., gravel containing developing eggs and alevins was subjected to movement during higher flows resulting in dislodgement or burial of eggs and alevins). Coho salmon production had a medium potential to be limited by gravel quantity and quality (Table 5-K-3). For coho salmon, gravel quantity was the responsible factor for the ranking. Lack of gravel in many streams probably is a consequence of both historic activities, such as splash damming. (Splash dams were structures constructed on streams that created ponds. Logs were either dropped into the pool behind the dam or in the channel downstream. The dam was opened, generally during periods of high stream flows. The resulting flow then transported the logs downstream. The consequence of this was that stream channels were straightened and often scoured to bedrock.) More recent activities, such as stream channel clearance, have also reduced or eliminated the amount of large wood that trapped and stabilized gravels in coastal streams.

Many facets of rearing habitat were identified as having high potentials to limit every species and race of anadromous salmonids except fall chinook salmon (Table 5-K-3). Increased water temperature was important along the south coast. Reduced numbers of deep complex pools and large sized wood in streams have resulted in a simplified rearing habitat that has a high potential for limiting several species and life history stages. Wetland and estuarine rearing areas have also been degraded. Riparian areas presently have very few large trees growing within 100 to 200 feet of the stream, suggesting that streamside recruitment of large wood will be deficient for decades. Alteration of both high and low streamflows caused by irrigation withdrawal, forest management activities, and stream channel simplification has limited the natural productivity of many streams. Species and fish stocks that rear in fresh water for extended periods were believed to be most affected.

Large Wood - Large wood is essential for creating and maintaining good fish habitat in streams (Bisson et al. 1987). Large wood influences the routing and storage of sediment and wood, affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Swanson et al. 1982, Bisson et al. 1987). Refer to reviews by Bisson et al. (1987), Maser et al. (1988), and Naiman et al. (1992) for more detail on the role and function of large wood. Wood enters streams inhabited by fish either directly from the adjacent riparian zone or from upslope tributaries and hillslopes that are accessible to or not inhabited by anadromous fish (Naiman et al. 1992).

Large wood in streams has been reduced because of a variety of past and present-day timber harvesting and associated activities. Buffer zones have been inadequate because they have been too narrow and were vulnerable to windstorms and floods. In addition, harvest and salvage logging operations in buffer zones have further reduced the long-term recruitment of large wood (Bryant 1980, Bisson et al. 1987). Also, the absence of vegetative buffers in tributaries not inhabited by fish may eliminate sources of large wood for streams inhabited by fish (Naiman et al. 1992). Debris flows and dam-break floods resulting from timber harvest activities may remove large wood from channels and riparian vegetation from streambanks (Benda and Zhang 1990, Swanston 1991) on one portion of a drainage system and deposit this material downstream.

The absence of wood in many streams may also be the legacy of past activities. Mandated cleanup activities removed wood from streams throughout the region of the northern spotted owl from the 1950's through 1970's (Narver 1971, Bisson and Sedell 1984). Earlier activities such as splash-damming networks that stored water to be released to flood streams and transport logs, also removed large amounts of wood from streams (Sedell and Luchessa 1982, Sedell et al. 1991).

Habitat Complexity - A primary factor influencing the diversity of stream fish communities is habitat complexity. Attributes of habitat complexity include the variety and range of hydraulic conditions (i.e., depths and water velocities) (Kaufmann 1987), number of pieces and size of wood (Bisson et al. 1987), the types and frequency of habitat units, and the variety of substrates (Sullivan et al. 1987). More complex habitats support more diverse assemblages and communities (Gorman and Karr 1978, Schlosser 1982, Angermeier and Karr 1984). Habitat diversity can also mediate biotic interactions such as competition (Kalleberg 1958; Hartman 1965) and predation (Crowder and Cooper 1982; Schlosser 1988).

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

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

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

Changes in the water temperature regime can affect the survival and production of anadromous salmonids, even when temperatures are below levels considered to be lethal. For example, Reeves et al. (1987) found that interspecific competition between redside shiners (*Richardsonius balteatus*) and juvenile steelhead was influenced by water temperature; trout dominated at temperatures (<68°F) and shiners at temperatures (>68°F). In Carnation Creek, British Columbia, water temperatures during both summer and winter changed because of timber harvest activities. The consequence of this was accelerated growth and earlier migration of juveniles (Holtby 1988). However, Holtby speculated that survival of coho salmon to adults would decrease because of the earlier time of ocean entry. Berman and Quinn (1991) found that fecundity and variability of eggs of spring chinook salmon were affected by elevated water temperatures.

Sediments - Increased levels of sediment can have negative impacts on anadromous fish and their habitat. Developing eggs and embryos of anadromous salmonids generally require gravel with <20 percent fines, which may vary in size from silt to sand (Bjornn and Reiser 1991). Survival of developing eggs and alevins decreases as the levels of fines increase (Cederholm and Reid 1987, Chapman 1988, Scrivener and Brownlee 1989, Everest et al. 1987, Bjornn and Reiser 1991). Also, fine sediment that is deposited or in suspension can reduce primary production and benthic invertebrate abundance (Cordane and Kelly 1961, Lloyd et al. 1987). This can reduce food availability for fish.

Increased sediments in streams can be a result of timber harvest and associated activities. Infilling of spawning gravel by fine sediments may result from accelerated erosion of road surfaces and by road failures (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ketcheson and Froehlich 1978, Marion 1981, Furniss et al. 1991, Megahan et al. 1992, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985, Cederholm and Reid 1987). Slope failures following harvest on unstable slopes may also result in increased levels of sediment (O'Loughlin 1972, Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ziemer and Swanston 1977, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Scrivener and Brownlee 1989).

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

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

CONSERVATION STRATEGY FOR FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

In keeping with the principles and information presented in the previous sections, we have developed a conservation strategy for fish habitat in National Forests within the range of the northern spotted owl. The strategy is designed to provide a high probability for maintaining and restoring habitat for fish. Its focus is on maintaining and restoring ecological functions and processes that operate in a watershed to create habitat. We believe this type of approach is both prudent and necessary given the current perilous state of many native fish stocks of salmon and trout (Nehlsen et al. 1991, Higgins et al. 1992, USDI 1992), resident fish (Williams et al. 1989, USDI 1992), and other riparian dependent organisms (USDI 1992, Chapter 5 of this report) found on Federally managed lands within the range of the northern spotted owl.

This conservation strategy is a slightly modified version of one of 8 scenarios for managing anadromous salmonid habitat in National Forests in Idaho, Oregon, Washington, California, and Alaska evaluated as part of the Forest Service's Pacific Salmon Workgroup and Field Team (hereafter referred to as the Pacific Salmon Workgroup, also known as "PacFish") (USDA 1992a). This strategy is not a modification in substance or content of the selected Pacific Salmon Workgroup alternative but in the geographic areas to which the alternative applies. The Pacific Salmon Workgroup is only concerned with anadromous salmonids. The present effort includes portions of two National Forests that do not have anadromous salmonids, the Deschutes and Winema National Forests, However, we believe that the strategy presented here is applicable for management of aquatic habitats on these lands. Both of these National Forests have populations of bull trout, which is currently being considered for threatened and endangered status, primarily because of the degradation and loss of its habitat.

The Scientific Analysis Team was not asked to develop a set of management alternatives as was done for the Pacific Salmon Workgroup. The Forest Service will continue to evaluate all alternatives developed by the Pacific Salmon Workgroup independent of the Scientific Analysis Team's effort. The Forest Service may opt to adopt or implement another management strategy which could have a lower or higher probability of maintaining and restoring aquatic habitat. Regardless of the Forest Service's decision upon completion of the Pacific Salmon Workgroup's Management Strategy for Pacific Salmon and Steelhead Habitat, the content and assessment of the conservation strategy for habitat of fish proposed by the Scientific Analysis Team will not change.

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

Rationale and Basis for Conservation Strategy

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

A second factor is that the current level of scientific understanding of fish habitat relationships does not allow us to define specific habitat requirements for fish throughout their life cycle at the watershed level. The general habitat needs of fish are well known (i.e., deep resting pools, cover, certain temperature ranges, clean gravels for spawning)(Bjornn and Reiser 1991). However, we cannot specify how these habitats and conditions should be distributed through time and space to provide for fish needs. Our understanding of fish habitat requirements is largely based on laboratory and site-specific studies that typically examine a single requirement for a single species at one point in its life cycle at a time. In natural watersheds, however, the different species and age-classes interact with multiple habitat elements in complex ways. This interaction occurs within a landscape where the quality and distribution of habitat elements change with time in relation to disturbance processes and land use-imposed changes on streams and riparian zones.

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

The disturbance regime of watersheds in the Pacific Northwest includes both geomorphic and non-geomorphic processes. Important geomorphic processes include mass movements (i.e., debris slides, debris flows, deep-seated landslides), peak streamflows, bank erosion, dam-break floods, and ice rafting (Swanston 1991). Non-geomorphic processes include fire, windstorms, and vegetation mortality due to disease and insects. These processes influence the input rate, quantity, quality, and movement of water, sediment, nutrients and wood through streams. It is the interaction of these elements with the channel and surrounding riparian zone that determines the abundance and quality of fish habitat within watersheds. Habitat degradation occurs where a change in the character of disturbance processes, such as in their frequency, duration, magnitude, severity, or legacy of physical structure, pushes this interaction outside the range of conditions to which fish have evolved. Most of the habitat degradation caused by human activities is due to increasing the frequency or magnitude of disturbances (i.e., landslides and debris flows [Swanston and Swanson 1976]), or decreasing the physical legacy of disturbances (e.g., by reducing the quantity or quality of large woody debris delivered to channels by landslides and debris flows [Naiman et al. 1992]).

Our strategy is to maintain as close to a "natural" disturbance regime as is possible within watersheds and landscapes, many of which have already been altered by human activities. We recognize that disturbances are essential to maintain good aquatic habitat. Typically, elements that physically create this habitat (i.e., boulders, large wood, gravel) are contributed to streams by episodic events (Naiman et al. 1992). However, the rate at which these episodic disturbances occur should not be significantly increased due to human activities. And, when these disturbances do occur, they retain all of the elements necessary to create high quality habitat.

Doing this requires several approaches. Land-use activities need to be limited or excluded in parts of the landscape prone to geomorphic disturbances, such as mass movements or bank erosion. The distribution of land use activities, such as clearcuts or roads, needs to be analyzed to ensure that peak streamflows are not being increased. Headwater riparian zones need to be protected, so that when debris slides and flows occur, they contain large wood and boulders necessary for creating habitat further downstream. Riparian zones along larger channels need protection to limit bank erosion due to trampling, grazing, and compaction, to ensure an adequate and continuous supply of large wood to channels, and to provide shade and microclimate protection.

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

RIPARIAN MANAGEMENT OBJECTIVES

Riparian and aquatic ecosystems are physical-biological systems in or near surface waters that have primary values associated with water and the proximity of land to water (Gregory et al. 1991). These ecosystems include terrestrial, semi-aquatic (land/water interface), and aquatic components and habitats. To manage ecosystems, it is crucial to analyze the whole system by pulling individual system components together and then evaluating all important influences, interconnections, and interactions (Naiman et al. 1992).

Riparian and aquatic ecosystems in National Forests within the range of the northern spotted owl will be managed to achieve the following specific riparian objectives:

1. Maintain or restore water quality to a degree that provides for stable and productive riparian and aquatic ecosystems. Water quality parameters that apply to these ecosystems include timing and character of temperature, sediment, and nutrients.

2. Maintain or restore the stream channel integrity, channel processes, and sediment regime under which the riparian and aquatic ecosystems developed. Elements of the sediment regime include the timing, volume, and character of sediment input and transport.

3. Maintain or restore instream flows to support desired riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges.

4. Maintain or restore the natural timing and variability of the water table elevation in meadows and wetlands.

5. Maintain or restore the diversity and productivity of native and desired non-native plant communities in riparian zones.

6. Maintain or restore riparian vegetation to provide an amount and distribution of large woody debris characteristic of natural aquatic and riparian ecosystems.

7. Maintain or restore habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities.

8. Maintain or restore riparian vegetation to provide adequate summer and winter thermal regulation within the riparian and aquatic zones.

9. Maintain or restore riparian vegetation to help achieve rates of surface erosion, bank erosion, and channel migration characteristic of those under which the desired communities developed.

10. Maintain and restore riparian and aquatic habitats necessary to foster the unique genetic fish stocks that evolved within that specific geo-climatic ecoregion.

Components of the Fish Habitat Conservation Strategy

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

Component 1 - Designated Lands Providing Habitat Protection - Refugia or designated areas providing high quality fish habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Refugia are habitats or environmental factors that convey protection to biotic communities at different temporal and spatial scales. Examples of aquatic refugia range from clean gravels at the particle scale, to well vegetated floodplains and side channels at the channel reach scale, to the condition of the whole watershed at the watershed scale (Sedell et al. 1990). In a review of case histories of recovery of aquatic systems following disturbance, Yount and Niemi (1990) and Niemi et al. (1990) found considerable evidence that the existence of spatial refugia–undisturbed habitats providing a source of colonists to adjacent areas–was critical to enable recovery of degraded systems. In stream systems where disturbance was widespread and no accessible refugia remained, biological recovery was delayed or entirely precluded.

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

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

Watersheds that serve as refugia are crucial for maintaining and recovering habitat of at-risk stocks of anadromous salmonids and species of resident fish. These refugia should include areas that currently have good habitat as well as areas of degraded habitat. Areas presently in good condition would serve as anchors for the potential recovery of depressed fish stocks. Congressionally designated Wilderness, National Recreation Areas, and other specially designated areas currently contain high quality fish habitat in National Forests within the range of the northern spotted owl, and currently provide habitat for at-risk stocks and species. Habitat Conservation Areas identified for the northern spotted owl also contain some high quality fish habitat. However, less than 25 percent of the area of key watersheds identified by Johnson et al. (1991) were in Habitat Conservation Areas. Additionally, Habitat Conservation Area boundaries seldom encompass entire watershed boundaries and frequently do not contain an entire stream from headwaters to fish-bearing streams. Although these areas would be the anchors of a watershed refugia system, additional watersheds that currently have low quality habitat would become future sources of good habitat with the implementation of a comprehensive restoration program (Component 4).

A network of key watersheds located in National Forest throughout the range of the northern spotted owl was identified by Johnson et al. (1991) (Figures 5-K-2 through 5-K-4). These watersheds contain at-risk fish species and stocks and either good habitat or if they have habitat that is in a degraded state, have a high restoration potential (Reeves and Sedell 1992). Forest Service fish biologists in northern California have deleted some watersheds that were identified by Johnson et al. (1991) and added others. These changes are reflected in Figure 5-K-2. Under the Fish Habitat Conservation Strategy, key watersheds require a level II Watershed Analysis (Component 3). Key watersheds with poor habitat also receive priority in any restoration program (Component 4).

Establishment of a network of key watersheds is crucial for maintaining and restoring fish habitat in National Forests within the range of the northern spotted owl. In the short-term, identification of basins with good habitat and implementation of the components of this strategy will reduce the potential of future habitat loss or degradation. These areas would not only serve as physical refugia but also as source of individuals for recolonization of degraded areas as they improve. They will also be critical to initiate the restoration of degraded areas because of the extensive amount of habitat that is in poor condition due to the effects of past land-management activities. Key watersheds that currently contain poor habitat are believed to have the best opportunity for success.

The network of key watersheds, although crucial, will not be sufficient to assure the recovery of at-risk fish stocks. Key watersheds are important because they contain at-risk fish stocks and the best habitat or potential habitat. It is important, however, to limit those land-use activities that are destructive to fish and associated riparian-dependent species in all National Forests, whether in a key watershed or not. Riparian Habitat Conservation Areas must be established in all National Forests within the range of the northern spotted owl.

Component 2 - Riparian Habitat Conservation Areas - For Forest Service streams and lands to function as refugia, special considerations need to apply to those parts of watersheds which directly contribute to creating or maintaining aquatic habitat. Riparian Habitat Conservation Areas are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. Riparian Habitat Conservation Areas encompass those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect streams, stream processes, and fish habitats. Riparian Habitat Conservation Areas include not only the more common Land and Resource Management Plan-designated riparian management zones or streamside management zones adjacent to rivers, streams, springs, seeps, wetlands, and marshes but also includes primary source areas for wood and sediment such as landslides and landslide-prone slopes in headwater areas and along streams. Riparian Habitat Conservation Areas generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic processes (Figure 5-K-5). Every watershed in National Forests within the range of the northern spotted owl will have Riparian Habitat Conservation Areas.

Establishment of Riparian Habitat Conservation Areas will confer benefits to riparian dependent and associated species other than fish. It will enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas. For example, many amphibians depend on wood created habitat in headwater streams (Bury et al. 1991, Chapter 5 this document). Improved travel and dispersal corridors for many terrestrial animals and plants and a greater connectivity of the watershed should also result from delineation of Riparian Habitat Conservation Areas.
Final boundaries of the Riparian Habitat Conservation Area in a watershed are determined by watershed analysis (Component 3). However, we have established a set of interim widths of Riparian Habitat Conservation Areas for all watersheds that will apply until the watershed analysis has been completed. The widths are designed to provide what we believe is a full measure of fish habitat and riparian protection until this analysis can be completed.

a. Interim Widths of Riparian Habitat Conservation Areas for Different Water Bodies

Interim widths of Riparian Habitat Conservation Areas vary with type of water body. They are defined as: 1) fish-bearing streams; 2) non-fish-bearing streams; 3) lakes; 4) ponds, reservoirs, and wetlands; and 5) other seasonally flowing or intermittent, streams. Streams in the last category may have little effect on fish habitat individually, but are collectively essential for maintaining processes that affect fish habitat. The last category also includes hydrologically, geomorphically, and ecologically significant areas such as landslides and landslide-prone areas, springs, seeps, marshes, and wetlands.

Several factors were considered in establishing interim widths of Riparian Habitat Conservation Areas for each stream type. One was how the various geomorphic and ecologic functions provided by riparian areas change with distance from the stream and with stream size. Key riparian processes considered in developing widths included sources of input of large and small woody debris and litter, shading, and buffering streams from the effects of strong winds and other microclimatic fluctuations (Gregory et al. 1991). We also considered the roles of vegetated and undisturbed floodplains in maintaining functioning side channels (used by fish for overwintering and refugia during peak flows) and hyporheic zones (which may supply cool or nutrient-rich groundwater during summer months) (Naiman et al. 1992). Additionally, we considered the use of Riparian Habitat Conservation Areas as breeding and rearing areas and dispersion corridors for organisms other than fish (Gregory et al. 1991, Gomez 1992).

Riparian areas contain a wide range of conditions along streams, lakes, springs, and wetlands. These include wide floodplains, narrower canyon reaches, multiple stream channels, and a diverse array of species and age-classes of vegetation. Many of these features are influenced by natural and anthropogenic disturbances (Grant 1986, Naiman et al. 1992). Boundaries of riparian areas are highly variable and irregular as a result of the natural character of the landscape and the local disturbance history. This variability and irregularity must be taken into account when planning land-management activities.

Physical features of streams vary widely with stream size. Inner gorges and floodplains are common in streams in National Forests within the range of the northern spotted owl. Inner gorges consist of the steep slopes immediately adjacent to a stream or river channel or floodplain and extend to the first significant break in slope. Widths of inner gorges on permanently flowing streams vary from 25 to 450 feet (M. Furniss, Six Rivers National Forest, personnel communication). Widths of the 100 year floodplains for permanently flowing streams vary from 50 to 800 feet in National Forests within the range of the northern spotted owl (Gregory and Ashkenas 1990).

An intact riparian forest in inner gorges and on 100-year floodplains is crucial for creating and maintaining habitat for fish and other riparian-dependent species (Gregory et al. 1991, Naiman et al. 1992). Riparian areas contribute wood and sediment to inner gorge areas. In smaller streams, the wood creates breaks in the channel gradient and forms pools for fish and other aquatic organisms. The wood also creates area of storage for sediment and organic material, which is a major energy source for organisms used as food by fish and other aquatic organisms (Bisson et al. 1987, Bilby and Ward 1991). Inner gorges may also be source areas of wood, sediments, and nutrients for wider floodplain areas located downstream (Gregory et al. 1991, Naiman et al. 1992)

Intact forests on floodplains are sources of large wood and provide refugia for aquatic organisms during floods (Naiman et al. 1992). Wood in these areas helps form habitat (Bisson et al. 1987), creates complexity (such as ranges of water velocities (Kaufmann 1987), and sites of material storage and nutrient processing (Bisson et al. 1987). Riparian vegetation in these areas may also influence the effect of flood events on the channel (Grant 1986, Sedell and Beschta 1991).

Several important processes and functions that influence the stream channel occur within 200 feet of the channel. McDade et al. (1990) and Van Sickle and Gregory (1990) reported that >90 percent of the wood in streams originated in this area. Stream bank stability is achieved within a distance equivalent to 0.5 to 1 site-potential tree height, which is generally within 200 feet of the channel (Sedell and Beschta 1991). Litter fall, nutrient retention and input (Gregory et al. 1987) and shade functions (Beschta et al. 1987) also generally occur within 100-200 feet of the channel.

Several studies (Steinblums 1977, Franklin et al. 1981, Heimann 1988, Andrus et al. 1988, Ursitti 1991, and Morman 1993) have found the basal area of conifers, which reflects the size and number of trees present, to be less in riparian areas of second-growth forests than in late-successional and old-growth forests. Riparian stands in late-successional and old-growth forests contain approximately 300 feet^2 per acre of basal area of conifers. This is less than the basal area of conifers found in upslope areas of the same forest (Gregory and Ashkenas 1990, Long 1987). Riparian areas in second-growth forests <80 years old generally have less than 100 feet^2 per acre. Riparian areas in second-growth forests 80 to 140 years old contain slightly more than 100 feet^{2}of basal area of conifers.

Maintenance of riparian forests in late-successional and old-growth forests and restoration in second-growth forests will depend on regeneration rates of conifers in the future. Regeneration of conifers in the riparian zones of natural stands is dependent, at least in part, on downed large trees. Researchers at the Pacific Northwest Research Station, Corvallis, Oregon found that more than 80 percent of conifer regeneration in the riparian zones along coastal Oregon streams that they studied occurred on down logs. The role of nurse trees in forest regeneration in the Pacific Northwest is widely recognized (Harmon et al. 1986). In riparian zones, nurse trees originate within 0 to 400 feet of the active channel. Greater retention of live trees and snags in riparian stands and adjacent upslope source areas will enhance the generation of future riparian forests.

Microclimate variability within riparian zones may be influenced by the condition of upslope stands. Chen (1991) and Chen et al. (in press) found that air temperatures in old-growth Douglas-fir stands were altered by the effects of surrounding clearcuts. Air temperatures were altered from 180 to 360 feet (i.e., 1 to 2 tree heights) from the edge. Wind velocities were altered up to 5 tree heights. Raynor (1971) found velocites altered up to 8 tree heights. Fritschen et al. (1970) reported that the microclimate of young forest stands (i.e., 40 to 60 years old) was altered up to 400 feet from the edge of a cut. While all of these values were measures for upland forests, they probably reflect the edge effects of clear-cuts on the micro-climate of adjacent riparian forests. The greater the widths of Riparian Habitat Conservation Areas the more stable will be the microclimate within riparian forests.

The abundance of amphibians in Pacific Northwest forest and riparian zones is influenced by habitat conditions in riparian areas (Bury et al. 1991, Gomez 1992). Amphibians populations are generally found less than 900 feet from water sources (Nussbaum et al. 1983). Gomez (1992) found that rough-skinned newts, tailed frogs, and western redbacked salamanders were the most abundant species of herptafauna in upland and riparian areas along the Oregon Coast Range. These organisms were found up to 600 feet from streams but were most abundant within 300 feet. Many species have specific tolerance thresholds (e.g., temperature and moisture) or microhabitat requirements (e.g., headwater seeps or talus slopes). Many also require downed wood, but may differ in types of wood (e.g., snag, bark on a log, or bark on the ground) or a particular decay class of wood (refer to Chapter 5 more specific requirements of specific species). Alteration of microhabitat climate may influence the suitability of riparian conditions for riparian-dependent organisms.

Many mammal populations are also dependent on riparian areas. Doyle (1986 and 1990) found that riparian areas in old-growth forests in the Cascades of Oregon were source areas for upland small mammal populations. Abundance of small mammals in coastal forests of Oregon were greatest within 300 feet of the stream, even though individuals were found up to 600 feet away (Gomez 1992). Chapter 5 of this document and USDI (1992) identify several mammal species that use or are dependent on riparian zones. Riparian corridors may also be important as dispersal, travel, and migratory routes for mammals (Gregory et al. 1991). The size (and limits on activities within) Riparian Habitat Conservation Areas should create a variety of microclimate and habitat conditions required by the large number of riparian-dependent organisms. This in turn should potentially accommodate a diverse assemblage of riparian-dependent organisms.

A riparian buffer zone is bordered by two edges; one is the stream and the other the adjacent upslope area. Each side is subjected to different sets of disturbances. If harvested, the upland side of the riparian forest is subjected to increased mortality from blowdown and increased stress resulting from more variable air temperatures and altered rates of evapotranspiration. The consequence of the latter factors is increased susceptibility to insect and disease (Geiger 1965, Caruso 1973, Ranney 1977, Wagner 1980). On the stream side, the stream can influence the microclimate of the riparian forest. The wider the stream, the greater the edge effect in terms of temperature and wind exposure. Additionally, the riparian forest is influenced by flood events and natural movements of the stream channel across the floodplain. The persistence of a riparian forest area is related to its length and width, due to mortality caused on both edges.

We believe that the character of any conservation program for maintaining and restoring habitat for at-risk stocks of anadromous salmonids and species of resident fish must maintain ecosystem functions and processes to have a high probability of success. A program of this nature is necessitated by the large number of fish stocks at risk (112) and the overall poor conditions of habitat and aquatic ecosystems in National Forests in the range of the northern spotted owl. We believe that it is prudent and justified to require Riparian Habitat Conservation Areas widths to incorporate areas larger than traditional riparian management areas, at least in the interim until a watershed analysis is completed.

Maintaining the connectivity of all parts of the aquatic ecosystem is necessary for healthy watersheds and good fish habitat (Naiman et al. 1992). First and 2nd-order streams, which generally include the permanently flowing non-fish bearing streams and seasonally flowing or intermittent streams, may represent over 70 percent of the cumulative channel length in mountain watersheds in the Pacific Northwest (Benda et al. 1992). These streams are sources of water, nutrients, wood and other vegetative material for streams inhabited by fish and other aquatic organisms (Swanson et al. 1981, Benda and Zhang 1990, Vannote et al. 1980). Decoupling the stream network can result in the disruption and loss of functions and processes necessary for creating and maintaining fish habitat. The Riparian Habitat Conservation Area widths specified for the different stream and wetland types were developed to maintain connections in watersheds that are currently in good condition and to initiate recovery of the connections in degraded areas.

Based on these criteria, we identify five types of streams or water-bodies and define interim widths of Riparian Habitat Conservation Areas for each:

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

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

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

3. Lakes: The Riparian Habitat Conservation Area consists of the body of water and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet horizontal distance, whichever is greatest.

4. Ponds, Reservoirs, and Wetlands Greater Than One Acre: The Riparian Habitat Conservation Area consists of the body of water (the maximum pool elevation of reservoirs) or wetland and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet horizontal distance, whichever is greatest.

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

We believe that the interim widths of the Riparian Habitat Conservation Areas will provide protection for riparian forests and maintain ecological functions and processes necessary for the creation and maintenance of habitat for fish and other-riparian dependent organisms. Existing data could be used to argue for wider Riparian Habitat Conservation Area widths, at least in certain stream categories. However, the interim widths will fully protect ecologically important areas within a watershed, such as floodplains. Interim Riparian Habitat Conservation Areas will also be able to survive some mortality in the short-run and still maintain its ecological integrity.

We emphasize that Riparian Habitat Conservation Area widths are applied to all streams in National Forests within the range of the northern spotted owl until a watershed analysis has been completed. If watershed analysis finds that because of the characteristics of a given site, narrower or wider Riparian Habitat Conservation Areas would provide the better function than the interim Riparian Habitat Conservation Area, then the Riparian Habitat Conservation Area width could be changed, and any allowable management activities would be adjusted to reflect these new Riparian Habitat Conservation Area dimensions.

A conceptual example of a Riparian Habitat Conservation Area is shown in Figure 5-K-5. This watershed is characterized by a stream drainage network that consists of a major fish-bearing stream, several fish-bearing tributaries, and some non-fish-bearing intermittent tributaries. The watershed also contains a marshy area near the watershed outlet, a large, inactive landslide, and many landslide-prone areas in steep terrain near the watershed boundary. The Riparian Habitat Conservation Area extends around and includes all these features.

b. Standards and Guidelines for Riparian Habitat Conservation Areas

Developing prescriptions for improving anadromous fish habitats includes formulating standards and guidelines that address the types of management activities that are allowed in Riparian Habitat Conservation Areas. In general, these standards and guidelines prohibit activities in Riparian Habitat Conservation Areas that are not designed specifically to improve the structure and function of the Riparian Habitat Conservation Area and benefit fish habitat. Management activities in Riparian Habitat Conservation Areas must contribute to improving or maintaining watershed and aquatic habitat conditions described in the Riparian Management Objectives. When activities are found to detract from meeting the Riparian Management Objectives, those activities will be modified, rescheduled, or discontinued. Further, for areas where riparian conditions are presently degraded, management activities must be designed to improve habitat conditions.

The standards and guidelines that follow are not all-inclusive. Watershed and riparian area management on lands managed by the Forest Service is guided by a variety of direction, including Best Management Practices, Land and Resource Management Plans, Forest Service manuals and handbooks, and other plans and directives. For the lands contained within the Riparian Habitat Conservation Area, these standards and guidelines supersede other direction, unless the conflicting standard or direction affords greater protection to riparian and fish habitat values and better foster attainment of the Riparian Management Objectives.

<u>Timber Management</u>

TM-1. Prohibit scheduled timber harvest, including fuelwood cutting, in Riparian Habitat Conservation Areas. Allow unscheduled harvest only as described in TM-2 and TM-3.

TM-2. Where catastrophic events such as fire, flooding, volcanic erruptions, severe winds, or insect or disease damage result in degraded riparian conditions, allow unscheduled timber harvest (salvage and fuelwood cutting) to attain Riparian Management Objectives. Remove salvage trees only when site-specific analysis by an interdisciplinary team determines that present and future woody debris needs are met and other Riparian Management Objectives are not adversely affected.

TM-3. Design silvicultural prescriptions for Riparian Habitat Conservation Areas and allow unscheduled harvest to control stocking, reestablish and culture stands, and acquire desired vegetation characteristics needed to attain Riparian Management Objectives.

<u>Roads Management</u>

RF-1. Keep road and landing construction in Riparian Habitat Conservation Areas to a minimum. No new roads or landings will be constructed in Riparian Habitat Conservation Areas until watershed, transportation, and geotechnical analyses are completed. Appropriate standards for road construction, maintenance, and operations will be developed from this analysis to ensure that Riparian Management Objectives are met. Valley bottom and mid-slope road locations may be used only when this analysis indicates that roads can be constructed and maintained in these locations and meet Riparian Management Objectives.

RF-2. Require that all roads on lands managed by the Forest Service, including those operated by others, are maintained and operated in a manner consistent with the planned uses and with meeting Riparian Management Objectives.

RF-3. Inventory and evaluate all existing roads in Riparian Habitat Conservation Areas. Through an interdisciplinary team review process, determine the influence of each road upon the Riparian Management Objectives. Roads that are found to pose a substantial risk to riparian conditions will be improved or obliterated. Priority will based on the potential impact to riparian resources, the ecological value of the riparian resources affected, and the need for each road. Roads not needed for future management activities will be closed, obliterated, and stabilized. All obliteration work will meet Riparian Management Objectives and provide for adequate long-term drainage and stability.

RF-4. Inventory and evaluate all existing culverts and stream crossings to identify those that present a risk to meeting Riparian Management Objectives. Culverts and stream crossings found to pose a substantial risk to riparian conditions will be improved to accommodate at least a 100-year flood, including associated bedload and debris. Priorities for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. New stream crossings will be designed and constructed to accommodate at least the 100-year flood, including associated bedload and debris. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in case of crossing failure. In locations found to have a high potential for failure, the roadway surface and fills will be hardened to further lessen the chance of roadway failure or severe erosion should the crossing over-top.

RF-5. Locate, design, construct, maintain, and operate roads to minimize disruption to natural hydrologic flow paths. This includes road-related activities that would divert streamflow and/or interrupt surface or subsurface flow paths.

RF-6. Apply design, construction, and maintenance procedures to limit sediment delivery to streams from the road surface. Outsloping of the roadway surface is preferred unless outsloping would increase sediment delivery to streams or where outsloping is infeasible. Route road drainage away from potentially unstable channels and hillslopes.

RF-7. Construct, reconstruct, and maintain all road crossings of existing and historic fish-bearing streams to provide for fish passage.

RF-8. Develop and carry out a Road Management Plan that will meet the Riparian Management Objectives. As a minimum, this plan shall include provisions for the following activities:

a. Conduct post-storm inspections of roads known to contribute to degrading the riparian resources. Conduct timely maintenance if deficiencies are found.

b. Inspect and maintain all roads providing for passenger car traffic (maintenance levels 3-5) during storms having a predicted high potential to cause problems.

c. Inspect roads providing for high-clearance vehicle use (maintenance level 2) and those closed, but needed in the future (maintenance level 1), following each storm having a runoff event with a recurrence interval of 1 year or greater. Correct deficiencies that would contribute to degrading riparian resources before the next storm.

d. During annual road maintenance, give high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.

e. During rainy periods, exclude traffic from roads that do not meet all-weather standards (maintenance levels 2-5).

RF-9. Designate sites to be used as water drafting locations during project-level analysis, or as part of road maintenance for fire management planning. Do not locate drafting sites where instream flows could become limiting to aquatic organisms. During periods of low flow, examine the drafting site and decide if water can continue to be extracted from that site. Design, construct, and maintain water drafting sites so they will not destabilize stream channels or contribute sediment to streams.

RF-10. Prohibit sidecasting of loose material in Riparian Habitat Conservation Areas during construction or maintenance activities.

Grazing Management

GM-1. Promptly adjust grazing practices to eliminate adverse effects of domestic and wild ungulates on riparian resources. If adjusting practices is not effective, eliminate grazing until it is shown that grazing can be reestablished and still attain the Riparian Management Objectives. Establish vegetation reference areas to measure potential site productivity and stream channel morphology that would exist without grazing, and to monitor the status of the ecosystem. Vegetation reference areas are to be located in areas representative of the vegetative community and stream channel types to be managed. Reference areas may include exclusion plots, larger exclosures, or sites with a low disturbance history. In addition to reference areas, conduct systematic monitoring of vegetation status using standardized procedures to determine the effects of grazing on riparian ecosystems and the ability to attain the Riparian Management Objectives.

GM-2. Locate new livestock management and handling facilities outside Riparian Habitat Conservation Areas. For existing livestock management and handling facilities inside the Riparian Habitat Conservation Area that are essential to proper management, apply standards that assure that Riparian Management Objectives are met. Where these objectives cannot be met, require relocation of livestock management and/or handling facilities.

Recreation Management

RM-1. Develop recreation facilities, including trails, within Riparian Habitat Conservation Areas only when such development is compatible with the attainment of Riparian Management Objectives.

RM-2. Monitor the impacts of dispersed or developed recreation in Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education, use limits, more intensive maintenance, facility modification, and/or area closures. For example, harassment of fish during spawning or low water can be reduced by closing access roads or campgrounds during critical periods, or education of users.

RM-3. Coordinate with state agencies to eliminate non-native fish stocking, over fishing, and poaching.

Minerals Management

MM-1. For operations in Riparian Habitat Conservation Areas, ensure that adequate reclamation plans and bonds are included in approved plans of operation. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring disturbed areas to near pre-mining topography; isolating and neutralizing or removing of toxic or potentially toxic materials; salvaging and replacing topsoil; and preparing seedbed and revegetating to meet Riparian Management Objectives.

MM-2. Avoid locating permanent structures or support facilities within Riparian Habitat Conservation Areas. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to meet the Roads Management Standards and to minimize damage to resources in the Riparian Habitat Conservation Area. When a road is no longer required for mineral activity, it will be closed, obliterated, and stabilized.

MM-3. Avoid locating waste dumps in Riparian Habitat Conservation Areas. If no other alternative exists, ensure that safeguards are in place to prevent release or drainage of toxic or other hazardous materials.

MM-4. For leasable minerals, prohibit surface occupancy within Riparian Habitat Conservation Areas for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Where contracts already exist, modify the operating plan to meet the Riparian Management Objectives.

MM-5. Prohibit common variety sand and gravel mining and extraction within Riparian Habitat Conservation Areas (subject to valid permitted rights), unless mining and extraction are consistent with Riparian Management Objectives and needed for restoration purposes.

Fire/Fuels Management

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire management activities could damage long-term ecosystem health.

FM-2. Locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside of Riparian Habitat Conservation Areas. If the only suitable location for such activities is within the Riparian Habitat Conservation Area, an exemption may be granted following a review and recommendation by a resource advisor. The advisor will prescribe the location, use conditions, and rehabilitation requirements. Use an interdisciplinary team to predetermine suitable incident base and helibase locations.

FM-3. Prohibit application of chemical retardant, foam, or additives in Riparian Habitat Conservation Areas. An exception may be warranted in situations where over-riding safety imperatives exist, or, following a review and recommendation by a resource advisor, when an escape would cause more long-term damage.

FM-4. Design prescribed burn projects/prescriptions for areas next to Riparian Habitat Conservation Areas so that Riparian Habitat Conservation Areas are protected. Where riparian ecosystems would be enhanced by use of prescribed fire, clearly identify the specific objectives and risks.

FM-5. If Riparian Habitat Conservation Areas are significantly damaged by a wildfire or a prescribed fire burning out of prescription, establish an emergency interdisciplinary team to decide the rehabilitation treatments needed.

FM-6. Use minimum impact suppression methods in Riparian Habitat Conservation Areas. Consider potentially adverse effects of fire suppression effects and the potentially adverse effects of wildfire damage during initial fire size-up, initial suppression response, and in the development of the Escaped Fire Situation Analysis.

<u>Lands</u>

LH-1. For hydroelectric and other surface water development proposals, require instream flows and habitat conditions that maintain or restore riparian resources, channel conditions, and fish passage at levels that approximate favorable pre-project conditions. Coordinate this process with the appropriate state agencies. During relicensing of hydroelectric projects, make written and timely recommendations to Federal Energy Regulatory Commission that require flows and habitat conditions that maintain/restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate state agencies.

LH-2. Locate facilities that are not required within the Riparian Habitat Conservation Area (such as control rooms, housing, temporary construction buildings, etc.) outside the Riparian Habitat Conservation Area. Facilities within the Riparian Habitat Conservation Area will be located, operated, and maintained to minimize effects on riparian resources, including, for example, maintenance of upstream and downstream passages, and screening intakes and diversions.

LH-3. Review all Special Use Permits, rights-of-way, and easements affecting Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education or modification of existing Special Use Permits. When granting easements or other rights-of-way across lands managed by the Forest Service to reach private lands, apply these standards and guidelines to provide the terms and conditions necessary to protect riparian resources on lands managed by the Forest Service.

LH-4. Use land acquisition and exchange to consolidate in-holdings, with the priority to protect and restore fish stocks and species at risk.

General Riparian Area Management

RA-1. Exclude heavy equipment from Riparian Habitat Conservation Areas, unless specifically approved for road construction and maintenance, or unless an interdisciplinary team finds that proposed activity is needed to meet the Riparian Management Objectives.

RA-2. Fell hazard trees only when they are found to pose an unacceptable safety risk. Such trees may be removed from Riparian Habitat Conservation Areas only when adequate sources of woody debris remain to meet Riparian Management Objectives. If long-term sources of woody debris are inadequate, and a tree is found to pose an unacceptable safety risk, that risk must be reduced in a way that contributes to woody debris objectives.

Watershed and Habitat Restoration

WR-1. A watershed analysis is a prerequisite to planning, implementing, and monitoring all restoration projects. A Level I watershed analysis (see Component 3) may be sufficient to identify the causes of riparian area degradation, to set priorities for watershed restoration measures, and initiate restoration projects in critical areas. A full watershed analysis (Level II) is required, however, to develop an integrated basin-wide strategy for restoration and monitoring. Priority should be given to restoring key watersheds supporting at-risk stocks and species.

WR-2. Control the causes of riparian area degradation before initiating restoration projects.

WR-3. Employ restoration methods that promote the long-term genetic and ecological integrity of restored ecosystems.

WR-4. Where mixed ownership exists, encourage the development of Coordinated Resource Management Plans or other cooperative agreements to meet Riparian Management Objectives.

WR-5. Do not use mitigation measures or planned restoration as a substitute for preventing habitat degradation.

Component 3 - Watershed Analysis - Watershed analysis is a systematic procedure for characterizing watershed history, processes, landforms, and conditions to meet specific objectives. It is a prerequisite for determining which processes and parts of the landscape affect fish and riparian habitat, and is essential for defining appropriate boundaries for Riparian Habitat Conservation Areas. Watershed analysis forms the basis for evaluating cumulative watershed effects, defining watershed restoration goals and objectives, implementing restoration strategies, and monitoring the results or effectiveness of all these measures. Watershed analysis employs the perspectives and tools of multiple disciplines, especially geomorphology, hydrology, geology, fish and terrestrial ecology, and soil science. It is the framework for understanding and implementing land use activities within a geomorphic context and is a major component of the evolving science of ecosystem analysis. A critical step in this process is monitoring and feedback. If monitoring reveals that Riparian Management Objectives are not being met, the sequence of determining processes, defining Riparian Habitat Conservation Area boundaries and standards and guides will be repeated.

Watershed analysis consists of a sequence of activities designed to identify and interpret the processes operating in a specific landscape. The overall goals of watershed analysis are to:

1. Characterize the geomorphic, ecologic, and hydrologic context of a specific watershed with respect to neighboring watersheds, and identified beneficial uses.

2. Determine the type, aerial extent, frequency, and intensity of watershed processes, including mass movements, fire, peak and low streamflows, surface erosion, and other processes affecting the flow of water, sediment, organic material, or nutrients through a watershed.

3. Determine the distribution, abundance, life histories, habitat requirements, and limiting factors of fish and other riparian dependent species.

4. Identify parts of the landscape, including hillslopes and channels, that are either sensitive to specific disturbance processes or critical to beneficial uses, key fish stocks or species.

5. Interpret watershed history, including the effects of previous natural disturbances and land use activities on watershed processes.

6. Establish ecologically and geomorphically appropriate boundaries of Riparian Habitat Conservation Areas.

7. Design approaches to evaluate and monitor the reliability of the analysis procedure and the effectiveness of designated Riparian Habitat Conservation Areas to protect fish habitat.

8. Identify restoration objectives, strategies, and priorities.

The idea of watershed analysis is not new. Many National Forests have been conducting planning exercises that use elements of watershed analysis. However, few, if any, National Forests conduct a comprehensive watershed analysis. Furthermore, there is little consistency in objectives, methods, or results among Forests or ranger districts. Current efforts typically address only limited aspects of the problem (e.g., identifying unstable ground, or scheduling timber harvest to minimize the area in cutover or young stands at any given time). Little effort is made to identify effects of past practices or limiting factors for fish or other riparian dependent organisms. Watershed analysis falls between the scales of Forest and Project Planning; it is not a scale at which decisions are made. However, it is the critical scale for evaluating and making decisions about cumulative watershed effects.

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

Implementing watershed analysis will require major changes in Forest Service planning and management activities. To help with this transition, and to allow for planning and forest management activities to proceed in the face of the large task of performing watershed analysis in all National Forest watersheds in the owl region, two levels of analysis will be employed (Fig. 6-K-6):

Level I Analysis

Objectives: Level I analysis is less rigorous. It will assess current watershed conditions, identify watersheds currently providing or likely to provide high quality habitat, evaluate the ecologic and geomorphic processes critical for maintaining fish habitat, determine which watersheds require Level II analysis,and establish Riparian Habitat Conservation Area boundaries for watersheds not requiringLevel II analysis.

Scale: Level I analysis typically is conducted on watersheds from 10,000 to 100,000 acres (roughly 5th- to 6th-order).

Data used: Level I analysis typically relies on existing data, including topographic, geologic, soils, and vegetation maps; aerial photos; existing data on habitat and populations of fish and other riparian-dependent organisms; and existing mass movement inventories and streamflow records. Additional field work is required to set boundaries for watersheds not requiringLevel II analysis.

Products: Level I analysis assesses current watershed, riparian, and stream conditions and factors limiting fish habitat. Sequential aerial photos are examined to determine the frequency, magnitude, and spatial distribution of key disturbance processes within the watershed that influence fish habitat (e.g., landslides, debris flows, windthrow, fire). Streamflow records and channel inventories are used to determine if there is evidence for peak or low flow changes due to land management activities. Surveys of distribution and abundance or fish and other riparian-dependent species are used to determine if at-risk organisms are present. Past, ongoing, and foreseeable future projects are evaluated to determine their effects on disturbance regime and riparian habitat, and to determine if the Riparian Management Objectives are being met.

This information is used to determine whether past, present, or future management activities pose low, moderate, or high risk to riparian and stream habitat. For example, a watershed is classified as high or moderate risk if it has a history of slope instability, streamflow problems, threatened or endangered species or fish stocks, or management activities, either individually or collectively, that are likely to significantly change the disturbance regime contributing to fish habitat. Such a watershed requires a Level II analysis. For those watersheds where management activities pose a low risk to fish habitat, boundaries of Riparian Habitat Conservation Areas are delineated based on Level I analysis. These boundaries are established in the field using interim widths described in the previous section on Riparian Habitat Conservation Areas (Component 2) for different water bodies.

Time and personnel: Based on the time required to complete comparable efforts conducted by the Forest Service, Level I analysis should require approximately 5-7 weeks of a 4-person interdisciplinary team composed of a fish biologist, wildlife biologist, hydrologist, and geologist for a 50,000-acre watershed. This estimate assumes that topographic, geologic, soils, and vegetation map data and time-series aerial photographs are available.

Level II Analysis

Objectives: Level II analysis is more rigorous. It will establish ecologically appropriate boundaries of Riparian Habitat Conservation Areas, and identify restoration needs and priorities.

Scale: Level II analysis is carried out on watersheds of approximately 10,000 to 50,000 acres.

Data used: Level II analysis represents a refinement and extension of Level I analysis. Field maps of unstable areas, a road condition survey, inventory of riparian canopy conditions, intensive survey of channel conditions, and computer simulations of hillslope and channel processes would be used. Level II analysis typically involves additional field work to provide watershed-specific information on ecologic and geomorphic conditions.

Products: Level II analysis establishes operational boundaries of Riparian Habitat Conservation Areas to meet the Riparian Management Objectives, produces a transportation plan for the watershed, refine standards and guidelines to fit specific landscape conditions and limitations, establishes restoration goals, sets restoration priorities, and establishes a monitoring program to insure that Riparian Management Objectives are met.

Time and personnel: Level II analysis should require an additional 5-7 weeks of a 4-person interdisciplinary team for a 50,000-acre watershed. Total time to complete both Level I and II analysis of a 50,000-acre watershed should be approximately 40-56 person-weeks.

Because of their importance in providing high quality fish habitat and/or their high proportion of unstable landforms, all key watersheds (previously described) and inventoried roadless areas would require a Level II analysis.

Component 4 - Watershed Restoration - Watershed restoration addresses improving the current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic resources. To be effective in restoring salmonid habitats, a restoration strategy needs to incorporate:

- A regional strategy that looks across landscapes and ownerships to identify where restoration efforts are likely to be most effective;

- An explicit recognition of how differences in physiography and specific impacts on stream systems will require different restoration measures;

- A detailed watershed analysis (Component 3) to adapt restoration strategies to specific landscapes, taking into account unique watershed histories, conditions, and resources;

- A specific set of objectives for each watershed;

- An explicit role for research and monitoring in defining and refining restoration objectives and tracking the effectiveness of restoration measures.

Elements of a restoration program are:

a. Identification of Priority Watersheds - Priority watersheds for restoration should be those with high restoration potential. Prioritization is necessary because of the large number of watersheds in National Forests within the range of the northern spotted owl that are in poor condition. Additionally, funds for programs are currently lacking and probably never will be sufficient to deal with all watersheds. However, some watersheds have been altered so excessively that they have little potential of recovery. Candidate watersheds that have the best chance of benefiting from a restoration program have already been identified as part of the key watershed network of Johnson et al. (1991).

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

c. Watershed Analysis - Before any restoration activities begin, the watershed analysis described in Component 3 is needed. It will identify: watershed disturbance processes and where they occur on the landscape; current conditions of hillslopes and channels; status of aquatic communities including threatened and endangered populations; limiting factors for riparian ecosystems; inventory of past land use practices, including roads, clearcuts, grazing allotments, and mining impacts.

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

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

SUMMARY

This conservation strategy for habitat of at-risk stocks of anadromous salmonids and resident fish in the National Forests within the range of the northern spotted owl represents significant change from current management. It is a long-range program that maintains the existing balance of processes, functions, and habitat elements in intact aquatic and riparian ecosystems, and initiates the recovery of processes and functions in degraded systems. We believe that if this strategy is carried out in conjunction with other protection measures outlined in this plan, it will lead to a functioning landscape that buffers and absorbs disturbances to streams rather than amplifies them. In the long-term, we believe that if this conservation strategy is implemented, all streams in National Forests within the range of the northern spotted owl will eventually contain good fish habitat.

We reiterate that this fish habitat conservation strategy will not, by itself, prevent further declines or extirpation of at-risk stocks of anadromous salmonids. Reduction of the quantity and quality of freshwater habitat and disruption of ecological processes and functions are only one of the factors responsible for the decline of anadromous fish stocks. We believe that this strategy in combination with the other components proposed by the Scientific Analysis Team will accommodate the naturally dynamic nature of stream and riparian systems in the owl forests, help the recovery of degraded systems to more productive states, maintain options for future management, and sustain fish habitat and ecologically necessary riparian and watershed functions until additional knowledge allows us to implement new management measures.

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables

Table 5-K-1 At-Risk Species of Anadromous Salmonids and Resident Fish Found on National Forests Within the Range of the Northern Spotted Owl.

A. Anadromous Salmonids	
coho salmon	*Oncorhynchus kisutch*
chinook salmon	*O. tshawytscha*
sockeye salmon	*O. nerka*
chum salmon	*O. keta*
pink salmon	*O. gorbuscha*
steelhead trout	*O. mykiss*
sea-run cutthroat trout	*O. clarkii clarkii*
B. Resident Fish	
redband trout	*O. mykiss gibbsi*
bull trout	*Salvelinus confluentus*
Oregon chub	*Oregonichthys crameria*
Olympic mudminnow	*Novumbra hubbsi*

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Table 5-K-2 Changes in the Frequency of Large, Deep Pools (>50 yds^2 and >6 Feet Deep) Between 1935 and 1992 in Streams on National Forests Within the Range of the Northern Spotted Owl.

	1935-1945			1987-1992		
	Miles Surveyed	Number	Number/ Miles	Number	Number/ Pool	Percent Change
Western Washington						
Cascades						
Cowlitz River Basin	52.1	421	8.1	176	3.4	-58%
Lewis River Basin	4.8	22	4.6	13	2.7	-41%
Wind River Basin	35.4	75	2.1	80	2.3	10%
Coastal						
Grays River Basin	20.7	107	5.2	34	1.6	-69%
Elochoman River Basin	21.5	79	3.7	13	0.6	-84%
Abernathy Basin	8.3	3	0.4	3	0.4	-NC
Germany Basin	8.0	7	0.9	4	0.5	-44%
Coweeman River Basin	26.4	87	3.3	4	0.2	-94%
Eastern Washington						
Yakima River Basin	28.5	98	3.4	14	0.5	-85%
Wenatchee River Basin	60.7	143	2.4	125	2.1	-13%
Methow River Basin	119.0	106	0.9	52	0.4	-56%
Coastal Oregon						
Lewis and Clark River	10.4	47	4.5	10	1.0	-78%
Clatskanie River	15.5	135	8.7	20	1.3	-85%

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Table 5-K-3 Spawning and Stream Rearing Habitat Factors That Potentially Limit natural Production of Coastal Oregon Anadromous Salmonids. Factors were assessed as: H = has high potential to limit natural production and M = has medium potential to limit natural production. A "?" indicates that insufficient information exists for making a professional judgement; A "*" indicates a priority for gathering new information to help in restoration of fish populations (from: Panel on Factors Potentially Limiting Natural Production, Oregon Governor's Coastal Salmonid Restoration Initiative, Oregon Department of Fish and Wildlife, Portland, Oregon).

FACTOR 1: SPAWNING HABITAT

	Holding Pools	Migration Barriers	Gravel Quantity/Quality	Water Quantity/Quality	Temperature
Coho	-	-	M	-	-
Chum	-	M	H	M	-
Fall Chinook	M	-	H	?	-
Spring Chinook	M	-	H	?	M
Summer Steelhead	-	-	-	?	-
Winter Steelhead	-	-	-	-	-
Sea-run Cutthroat	?	M	?	-	-

FACTOR 2: STREAM REARING HABITAT

	Channel Complexity	Streamflow	Temperature	Migration Barriers	Flood Plain and Wetland	Other
Coho	H	M	H	?*	H	
Chum[1]	-	-	-	?*	-	
Fall Chinook	M*	M*	M*	?*	?*	
Spring Chinook	H*	M*	M*	?*	?*	
Summer Steelhead	H	H	H	?*	H	
Winter Steelhead	H	H	H	?*	H	
Sea-run Cutthroat	H	H*	H*	?*	H	

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

Anadromous Stocks

Figure 5-K-1 Range and Status of At-Risk Anadromous Salmonid Stocks and Resident Fish Species in Washington, Oregon, Northern California, and Idaho (see facing page).

This map was produced from a 1:500,000 scale stream network developed by the Environmental Protection Agency. Due to the small scale of the map, streams smaller than 5th order are not displayed. The result is that some small coastal and headwater tributaries are not depicted. The map represents available data for all land ownerships, both public and private. In basins with more than one stock at risk, the highest risk code was assigned to the entire drainage.

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

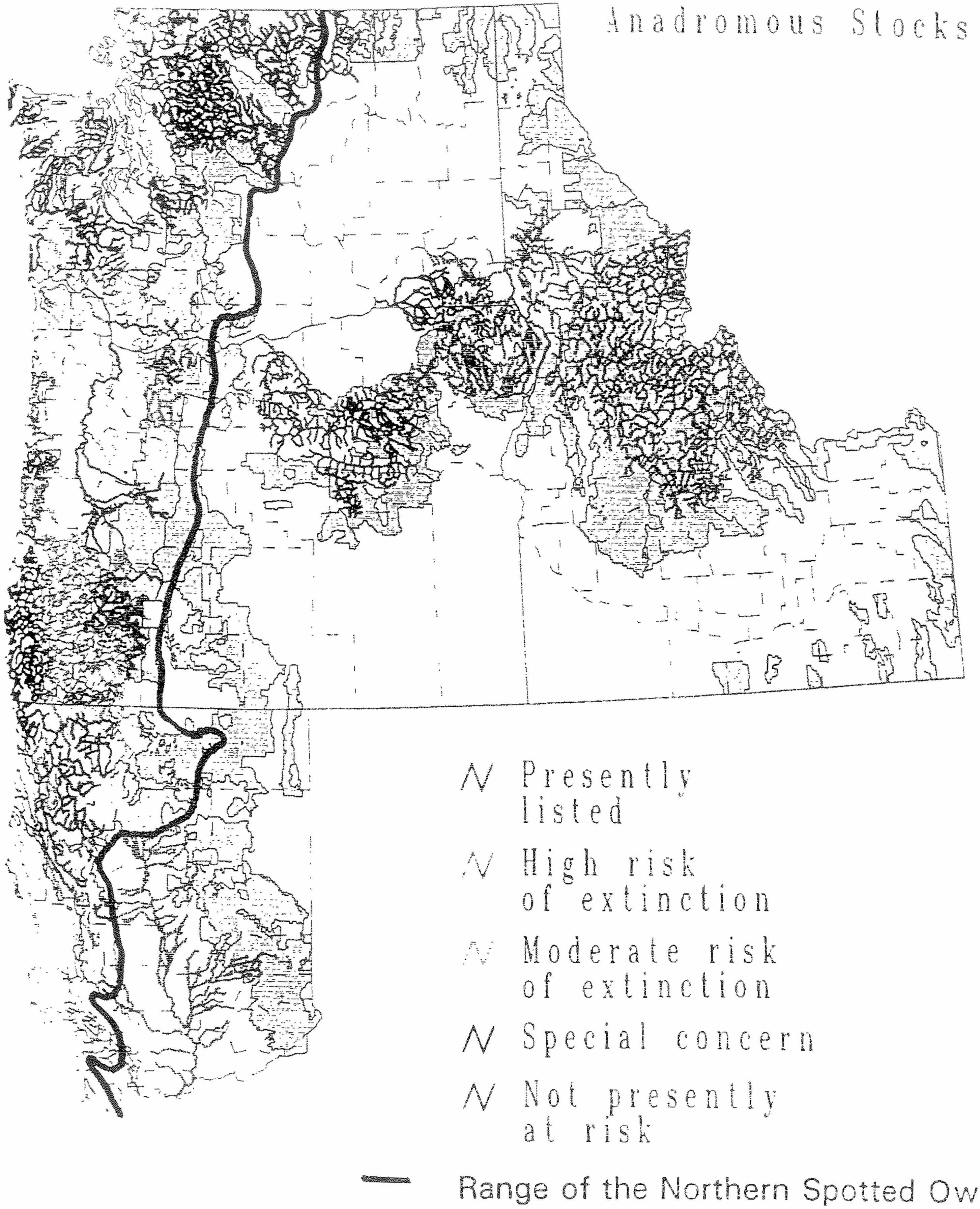
Presently Listed: stocks currently listed under the Endangered Species Act.

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

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

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

Data for this map were derived from Nehlsen et al. 1991, and Johnson et al. 1991.


Anadromous Stocks
Presently listed
High risk of extinction
Moderate risk of extinction
Special concern
Not presently at risk
Range of the Northern Spotted Ow

Washington Key Watersheds

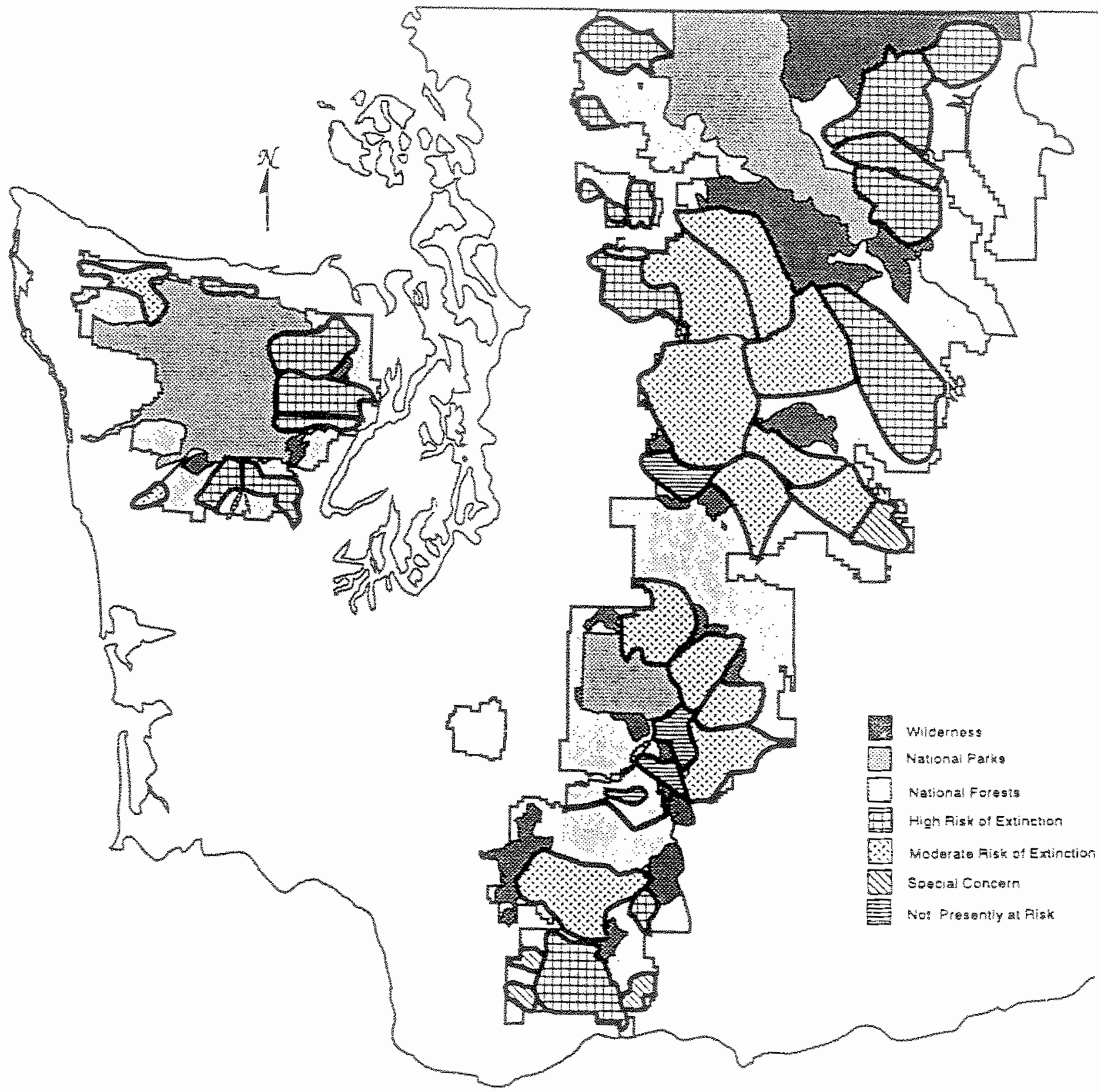


Figure 5-K-4 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in Washington and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

Schematic of a Riparian Habitat Conservation Area

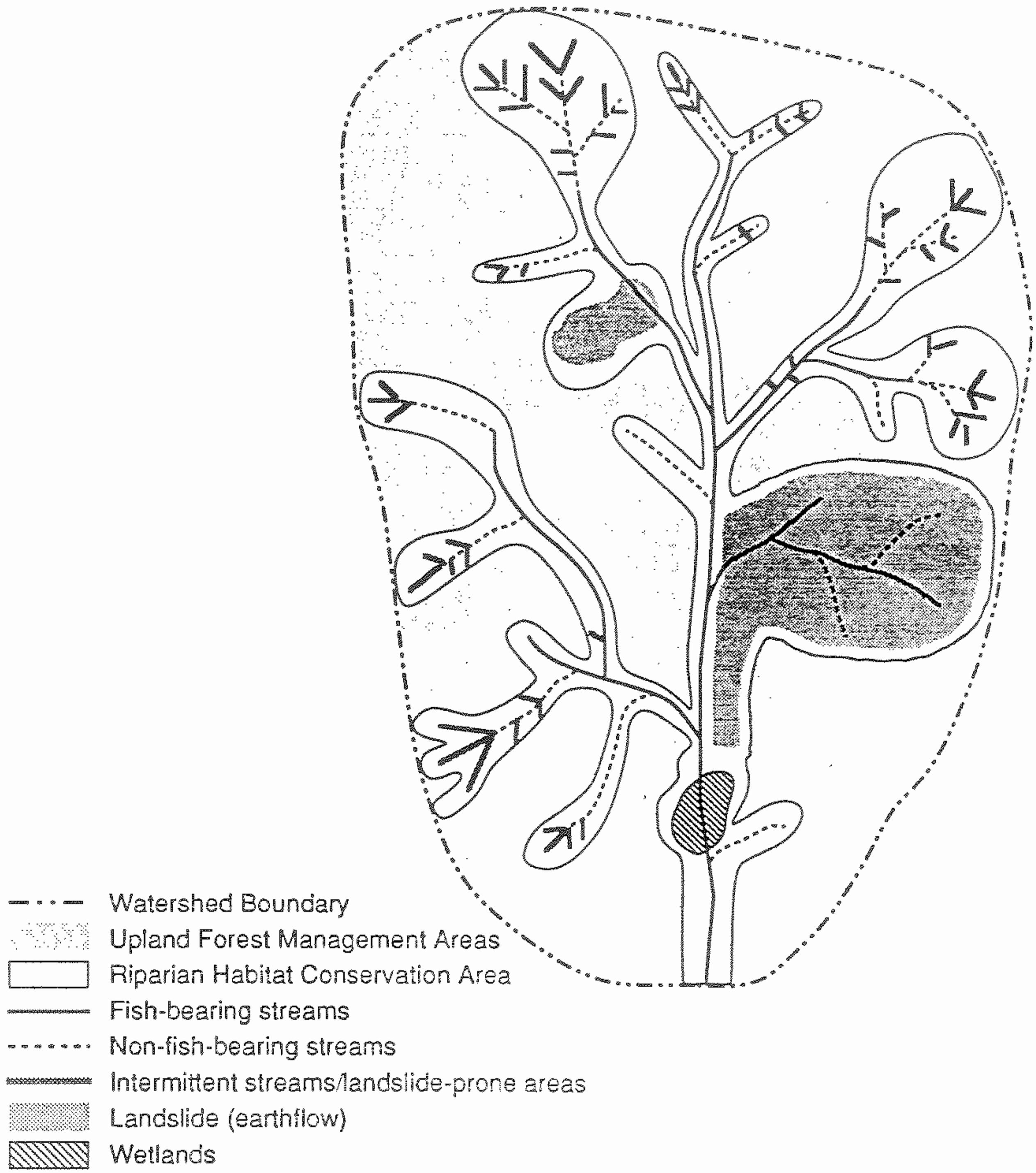


Figure 5-K-5 Schematic of a Riparian Habitat Conservation Area. Included within the Riparian Habitat Conservation Area are all seasonally flowing or intermittent streams, wetlands, landslides, and landslide-prone areas.

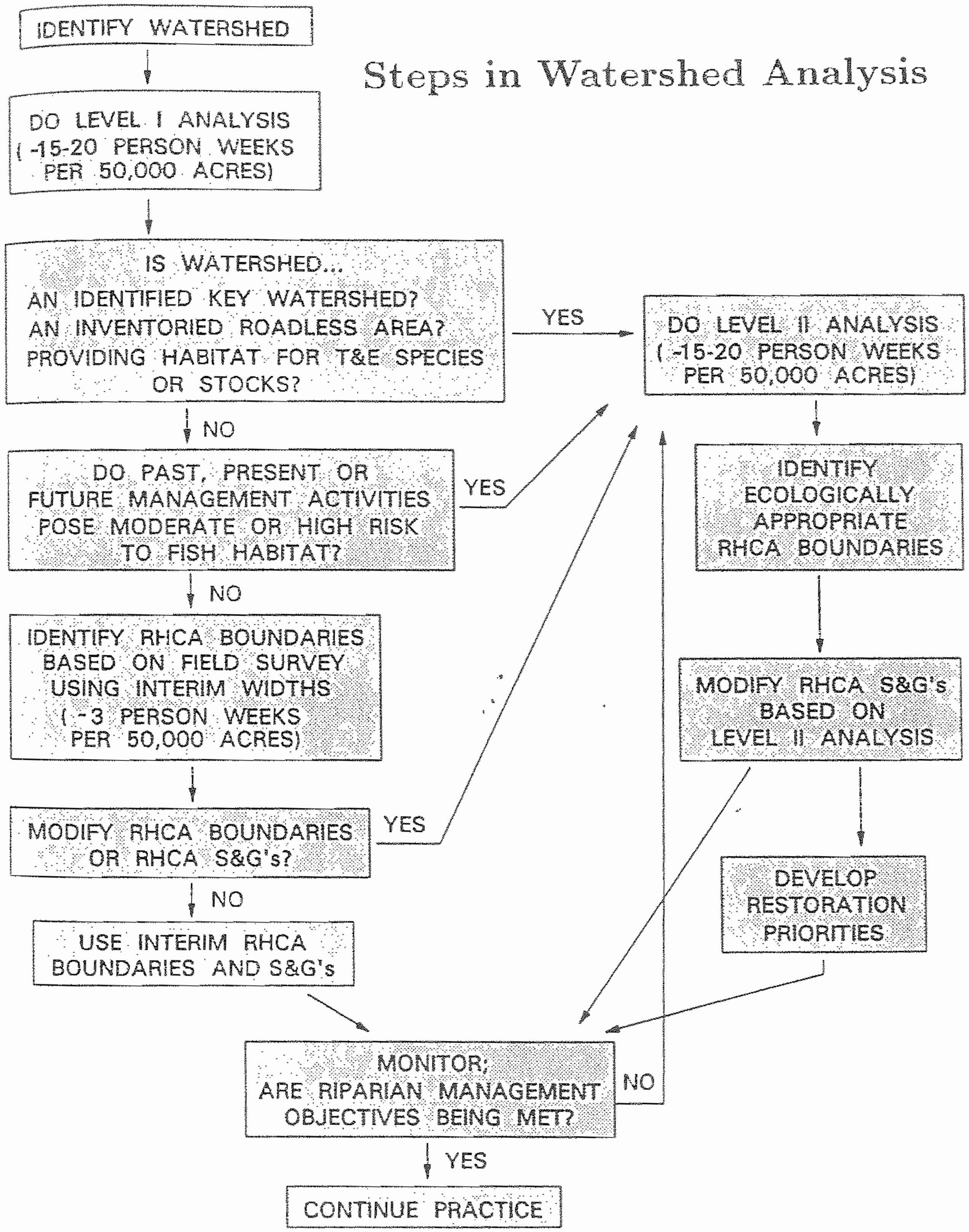


Figure 5-K-6 Flow Diagram of Proposed Watershed Analysis Procedure.

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

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