4.2.3 Description of the Riparian Ecosystem and a Comparison of the HCP Alternatives for Protection of Riparian Ecosystem Components

4.2.3 Description of the riparian ecosystem and a comparison of the HCP alternatives for protection of riparian ecosystem components

Summary

Protection of riparian ecosystems for the benefit of salmon habitat is necessary throughout the landscape of western Washington if these fish are to survive and prosper in the future. Because rivers and streams are a continuum, this will require cooperation from all state, federal, tribal, and private landowners that reside in the watersheds. The importance of several riparian ecosystem components (i.e., detrital inputs, large woody debris (LWD), windthrow, water temperature, sediment, stream bank stability, stream flow, and wetlands protection) as they relate to salmon protection were used in analyzing the riparian protection strategies for DNR-managed lands in western Washington. Three alternative approaches to riparian protection were developed and analyzed: Alternative A, the No Action alternative; Alternative B, the proposed HCP; and, Alternative C. The overall conclusion regarding the riparian protection provided by these three alternatives is that Alternative A is inadequate, Alternative B likely provides adequate protection, and Alternative C is the most protective.

Under Alternative A, the lack of specified minimum widths of riparian management zones on Type 4 Waters, the allowance of logging within 25 feet of streams, and the absence of wind buffers could result in damage to the riparian ecosystem components.

Riparian management zone widths under Alternative A would not always ensure protection of the riparian components because the minimum widths, as specified by the Washington Forest Practices Rules, are insufficient to fully protect riparian ecosystems. Current practices result in a wide range of application of riparian protection measures that in some cases are not sufficient to address salmon habitat needs (i.e., detrital inputs, water temperature, stream bank stability, LWD recruitment). Although not guaranteed, Alternative A would often result in sufficiently wide riparian management zones on Type 1 and 2 Waters, but may not be sufficiently protective of Type 3 and 4 Waters. Alternatives B and C both address the need for guaranteed riparian management zones on Type 1 through 4 Waters.

Logging within the riparian ecosystem is allowed under Alternative A. Under Alternatives B and C, logging is excluded from the 25 feet closest to the stream unless a part of restoration activities and minimized in the remainder of the riparian management zone. Alternatives B and C allow riparian restoration work to occur in the riparian management zones. These requirements recognize that many of the existing riparian areas are in need of enhancement if they are to be returned to a productive condition in the relatively near future. The measures specified under Alternatives B and C will ensure that stream bank integrity and riparian ecosystem productivity will be protected and potentially enhanced, which will benefit salmon.

Alternative A does not require a wind buffer on riparian management zones in wind-prone areas. The failure to address wind damage vulnerability of riparian management

zones in the past has resulted in frequent loss of riparian integrity and salmon habitat values. Alternatives B and C both specify that a wind buffer be added to riparian management zones in wind prone areas. 4.2.3 (1) "Alternative B requires the wind buffer to be added to the windward side of streams in areas prone to wind damage. Alternative C requires the wind buffer be added to both sides of streams."

Logging roads are a significant cause of sedimentation in salmon streams. Under Alternative A, DNR would continue to implement Forest Resource Plan direction to develop and maintain a road system that controls adverse environmental impacts. Alternatives B and C go even further by attempting to minimize the active road density based on a comprehensive road network management plan.

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Riparian			
Riparian Protection Area (west-side planning units)	Continued implementation of Forest Resource Plan; conservation strategies range from Forest Practices Rules minimums to substantial buffers applied on a site-specific basis. Review of 129 sales since implementation of FRP began shows no harvest in riparian management zones of following size on each side of stream: (1) Types 1 and 2 Waters, average riparian management zone width = approx. 196 feet, range = 0-350 feet. (2) Type 3 Waters, average riparian management zone width = approx. 85 feet, range = 0-300 feet. (3) Type 4 Waters, average riparian management zone width = approx. 55 feet, range = 0-300 feet. (continued)	Riparian management zones (each side of stream) defined as: (a) Type 1, 2, and 3 Waters: width = height of site tree at age 100 years or 100 feet, whichever is greater, (b) Type 4 Waters: width = 100 feet; and, (c) Type 5 Waters are protected "where necessary" according to FRP. Wind buffers added on windward side of riparian management zone where there is at least a moderate potential for windthrow: (a) Type 1 and 2 Waters, wind buffer width = 100 feet; (b) Type 3 Waters that are greater than 5 feet wide, wind buffer width = 50 feet. Riparian management zone activities: (a) no harvest except for restoration within first 25 feet, (b) minimal harvest between 25 and 100 feet, (c) low harvest beyond 100 feet.	Riparian management zone defined as: (1) riparian buffers on each side of Type 1 through 5 Waters - width = height of site tree at age 100 years or 100 feet, whichever is greater, (2) wind buffers added on both sides of riparian buffer: (a) Type 1 and 2 Waters, wind buffer width = 100 feet; (b) Type 3 Waters that are greater than 5 feet wide, wind buffer width = 50 feet, and (3) riparian buffer management activities: (a) no harvest within first 25 feet, (b) restoration activities allowed beyond 25 feet.

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Riparian (continued)			
Riparian Protection Area (west-side planning units) (continued)	(4) Type 5 Waters, riparian management zones on 47% of streams, average riparian management zone width for those streams = 40 feet. Remaining 53% receive no riparian management zones. Range on all = 0-150 feet.		
Unstable Hill slopes and Mass Wasting	No timber harvest on unstable slopes unless and until it can be done with no increase in failure rate or severity.	Same as Alternative A.	Same as Alternative A.
Road Network Management	Implement Forest Resource Plan direction to develop and maintain a road system that integrates management needs and controls adverse environmental impacts on the forest environment.	Implement Forest Resource Plan direction to develop and maintain a road system that integrates management needs and controls adverse environmental impacts on the forest environment. Minimize active road density based on comprehensive road network management plan.	Same as Alternative B.
Hydrologic Maturity	Hydrologic maturity addressed as part of Forest Practices watershed analysis. This process completed for only a small percentage of DNR- managed land. (continued)	Two-thirds of DNR-managed lands in the rain-on-snow zone, with some exceptions, to be hydrologically mature.	Same as Alternative B.

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Riparian (continued)			
Hydrologic Maturity (continued)	While not a specific requirement, hydrologic maturity is often considered when laying out harvest units, is included on the timber sale environmental checklist, and is part of the landscape planning process.		
Wetlands Protection	Wetlands protected in the future through full implementation of FRP Policy No. 21- "no net loss of acreage or function." Could change if policy is replaced or modified. Buffers provided based on size of wetland: (1) .25-1 acre wetlands, buffer width = 100 feet; and, (2) wetlands larger than 1 acre, buffer width = height of site tree at age 100 or 100 feet whichever is greater. Buffer and forested wetland management activities: (1) maintain at least 120 feet^2 of basal area in wind-firm trees with large root systems; (2) no roading without on-site mitigation; (continued)	Same as Alternative A. and guaranteed for length of HCP.	Same wetland buffers as in Alternatives A and B plus: (1) bogs 0.1-0.25 acres receive 100-foot buffers; (2) small wetlands that are interconnected or connected to a typed water are buffered; and, (3) wetlands within 200 feet upslope of unstable hill slopes have the buffer width increased by 50% on the half of the wetland closest to the unstable area. Management of forested wetlands and buffers around forested wetlands same as Alternative A plus: (1) the required 120 feet^2 of basal area consists of the most wind-firm dominant and co-dominant trees; (2) maintain a minimum of at least 75 trees per acre; and, (3) no ground-based equipment operation (continued)

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Riparian (continued)			
Wetlands Protection (continued)	(3) natural surface and subsurface drainage conditions must be maintained or restored; and, (4) ground-based equipment generally precluded.		within wetland or 50 feet of wetland edge. Management of buffers around nonforested wetlands same as forested wetlands plus: (1) no harvest within 50 feet of wetland edge; and, (2) no ground-based equipment within 100 feet of bogs.

Affected Environment

This section describes the riparian ecosystem and its various components, including: detrital input, large woody debris (LWD) recruitment, windthrow, water temperature, sediment, stream bank stability, stream flow, and wetlands; evaluates the way in which each HCP alternative would protect the components, and compares Alternatives B and C to Alternative A, the No Action alternative. All references to riparian management zone widths apply to both sides of the streams, unless otherwise noted.

Riparian Ecosystem

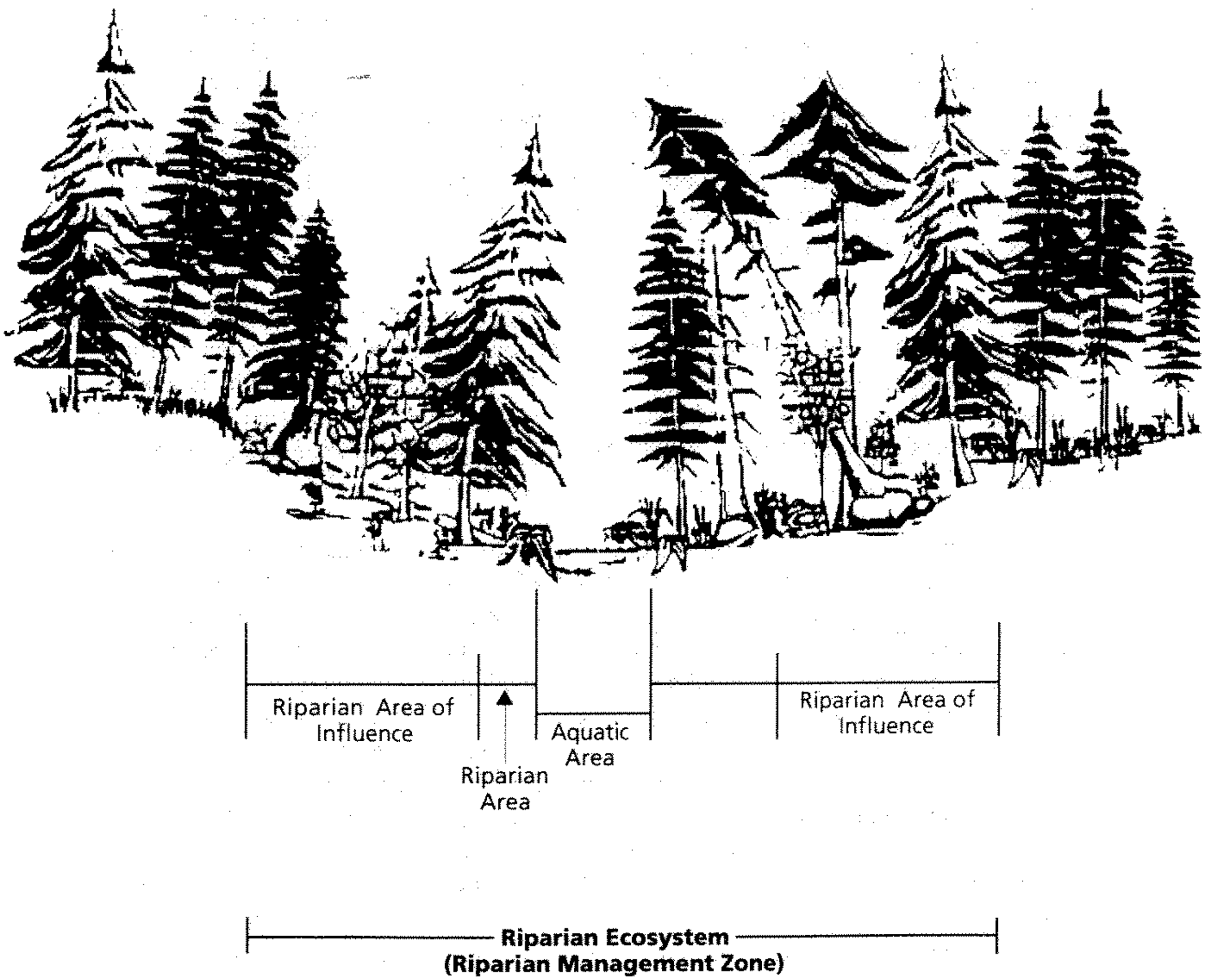
The riparian ecosystem includes, in addition to rivers, streams, lakes, ponds, wetlands, and other bodies of water, the land and corresponding flora and fauna occurring along the water bodies themselves. Within this area are found the physical and biological processes that function together as an extremely important water-driven habitat within the landscape (WFPB Riparian Habitat Technical Committee 1985; Cederholm 1994). The riparian discussion contained within this DEIS focuses on salmonid habitat in rivers and streams, with some reference to wetlands. Maintaining the various components of the riparian ecosystem within some level of natural background variability is critical to maintaining beneficial conditions for salmonids. It is important to realize that plant and wildlife species and communities within the riparian ecosystem are also dependent on good habitat quality (Raedeke 1988; Bilby 1988). The potential impacts on many of these species are discussed in Section 4.5.

Riparian ecosystems encompass the aquatic environment and both the riparian and upland vegetation communities. Riparian ecosystems are comprised of mosaics of land forms, plant communities, and environments that vary in width and shape within the larger landscape. As such, their boundaries do not stop at an arbitrary, uniform distance from the stream but are delineated primarily by how the ecosystem functions (Castelle et al. 1992).

A properly functioning riparian ecosystem includes the maintenance of cool clean water, stable stream banks, and short- and long-term LWD recruitment to the aquatic environment. Salmonid fish live within the aquatic environment from which they obtain the food and living space necessary for growth, reproduction, and survival. Each part of the aquatic environment has unique physical and biological characteristics and corresponding riparian components that are also unique. Riparian ecosystems directly and indirectly influence the quality of salmonid habitat. In areas of high wind intensity it is necessary to protect the riparian ecosystem from blowdown by providing additional width (i.e., a wind buffer) beyond the site potential tree height. Salmonids have evolved with specialized and unique habitat requirements that are met in part by healthy, functioning riparian ecosystems (Bisson et al. 1987; Hicks et al. 1991; Cederholm 1994). Some of the most important habitat requirements that salmonids derive from riparian ecosystems are clean well-oxygenated water, spawning gravel that is relatively low in fine sediment, an abundant food supply, a moderate hydrologic regime, cover provided by LWD, and other forms of aquatic diversity provided by wood.

The riparian ecosystem discussed in this DEIS includes the aquatic zone, riparian zone, and the zone of direct influence (Figure 4.2.11), all of which fall within the riparian ecosystem as described by the Washington Department of Ecology (WFPB Riparian Habitat Technical Committee 1985). While salmonids live in the aquatic environment, their welfare is directly dependent on how well the entire riparian ecosystem is functioning. When a watershed's uplands are logged, it is important to realize the potential impacts that can occur to the riparian ecosystem. Consideration of maintenance of the various components of salmonid habitat is important when logging and associated activities are carried out within watersheds.

Figure 4.2.11: The relationship between the riparian ecosystem and DNR's riparian management zone



When establishing the width of the riparian ecosystem, it is important to realize that measurements should start at the outer margin of the channel migration zone (flood plain). This is important because over the course of a timber rotation, streams naturally move laterally due to stream bank erosion. If riparian ecosystem widths are measured from the low flow wetted perimeter and not the outer margin of the flood plain, then the stream has less room to move through, and may eventually migrate outside the riparian ecosystem into the logged areas behind.

The input of detritus and large woody debris (LWD) to water bodies is of major importance as both a food base and a structural component of salmonid habitat. Detritus is the primary food base of many aquatic insects that are important in the juvenile salmonid diet (Mundie 1969; Waters 1969; Friesen 1990). Large woody debris provides both biological and physical structuring of stream channels that benefit salmonids (Bisson et al. 1987; Hicks et al. 1991; Naiman et al. 1992). Large woody debris input needs to include sufficient numbers, species, and sizes of wood to result in a productive aquatic environment for salmonids (Bisson et al. 1987; Naiman et al. 1992; FEMAT 1993).

The necessary width of riparian management zones, and the management activities that would be allowed within them, depends on the situation. If the riparian management zone is wide enough to provide LWD input at a natural background composition and rate, then it most likely will provide most of the required salmonid habitat protection (WFPB Riparian Habitat Technical Committee 1985; FEMAT 1993; Cederholm 1994). The Washington Forest Practices Board Riparian Habitat Technical Committee (1985) recommends a buffer of 200 feet on each side of the stream if the total riparian ecosystem is to be protected. For fishbearing waters, FEMAT (1993) suggests that protection of riparian ecosystem values may require a buffer equal in width to two site potential tree heights or about a 300-foot slope distance, the 100-year flood plain, or to the top of the inner gorge in order to protect the full range of riparian functions. Most riparian ecosystem functions (shade, bank stability, sediment filtering, and detritus input), and up to 80-90 percent of the LWD recruitment, will be met on these streams by a buffer width of 100 feet (McDade et al. 1990; FEMAT 1993 Figure V-12). The additional 10-20 percent of the LWD input is provided from beyond this distance. However, as riparian stands develop more late-successional characteristics, including a higher component of conifer and taller trees, proportionately more input will occur from distances beyond 30 meters (100 feet)(Van Sickle and Gregory 1990).

Other studies call for narrower buffer widths; however, the recommendations from these studies are often based on protection of individual riparian components (Castelle et al. 1992; Johnson and Ryba 1992) rather than the entire riparian ecosystem.

The riparian management zone that is left after harvest activity should be of sufficient width and condition to maintain the integrity of the riparian ecosystem. Whenever possible, the riparian management zone should at least encompass the riparian ecosystem and have a sufficient buffer width to allow for channel movement and external impacts (i.e., windthrow, landslides, etc.). For example, logging in the uplands can potentially change the conditions along the outer boundary of the riparian management zone, making it far more vulnerable to wind damage and sedimentation from upslope logging-associated activities. Therefore, the riparian management zone may have to be wider in areas of high wind vulnerability. Following harvest of the uplands, wind becomes more problematic for riparian management zones, because the removal of adjacent timber allows the wind to accelerate along the ground, resulting in a greater blowdown effect on the trees left standing. Sediment from unchannelled upslope land failures can usually be filtered out by riparian ecosystems if the riparian management zone is of sufficient width and composition. However, if protection of the riparian ecosystem is insufficient (i.e., too narrow or of low quality) sediment could reach the aquatic habitat (Castelle et al. 1992; Johnson and Ryba 1992). The preference would be that upslope stability would be maintained within some natural level of landslide occurrence, using comprehensive road construction and maintenance planning, avoidance of logging on unstable slopes, and maintenance of hydrologic maturity in the rain-on-snow zone.

Comparison of the HCP Alternatives for Protection of the Riparian Ecosystem Components

Detrital Inputs

Stream benthic communities (aquatic macroinvertebrates that live in the streambed) are highly dependent on detritus. Detritus is defined as all "dead" organic carbon as distinguished from "living" organic or inorganic carbon (Hicks et al. 1991). With respect to stream systems, detritus has two forms: (1) detritus originating within the stream (autochthonous); and, (2) detritus originating from outside of the stream (allochthonous). The primary form of autochthonous detritus is dead algae and other aquatic plant material. In small, forested mountain streams autochthonous detritus accounts for only a small portion of the total detrital input within the system. Allochthonous detritus is the primary source of detrital input into small- and medium-sized streams through the annual contribution of large amounts of leaves, cones, wood, and dissolved organic matter (Anderson and Sedell 1979; Gregory et al. 1987; Richardson 1992).

The types of aquatic insects that consume the detrital material differ as one progresses downstream in the river continuum (Vannote et al. 1980). In the small headwater streams (high in the river continuum) the aquatic insects classified as "shredders" dominate the population and these organisms actually shred and digest wood fiber. Downstream, in the larger, more exposed streams, the "collectors" dominate and these aquatic insects mainly graze the algae from the surface of stream gravels (Vannote et al. 1980).

The importance of this type of detrital input varies among streams but can provide up to 60 percent of the total energy of stream community metabolism (Richardson 1992). In deciduous riparian forests, 80 percent of the allochthonous input to streams is derived from leaf litter. Most of this input occurs within a 6-8 week period in the autumn (Naiman et al. 1992). In coniferous riparian forests, needles contribute a major portion of the allochthonous input to streams (Bilby and Bisson 1992), and fallen cones or wood may account for 40-50 percent of the total allochthonous detrital input (Naiman et al. 1992). Up to 90 percent of the detritus that ultimately remains in small coniferous forest streams is comprised of woody material (Naiman and Sedell 1979; Triska and Cromack 1980). The complete decay process takes about 1 year for most high quality materials such as leaves and herbaceous plants and may take several years or decades for low quality materials such as cones and wood (Gregory et al. 1991).

Stand age significantly influences detrital input to a stream system. Total input of allochthonous detritus to streams within old-growth forests is known to be approximately five times higher than in streams within clearcut forests (Bilby and Bisson 1992). Furthermore, Richardson (1992) found that allochthonous detrital input was approximately twice as high in old-growth forests as compared to either 30- or 60-year-old forests. However, reduced levels of allochthonous detrital input into streams due to streamside timber harvest is somewhat offset by concomitant increases in autochthonous detrital production. It isn't known what the effect of a change in type of detritus (allocthonous versus autochthonous) would have on the community structure in streams, however, several studies have documented increases in aquatic insect production and fish production after canopy removal (Murphy and Hall 1981; Bisson and Sedell 1984; Gregory et al. 1987; Hicks et al. 1991). Reduced forest canopy in the riparian zone leads to increased light levels in the aquatic zone, thereby increasing algae production in streams (Sedell and Swanson 1984; Bilby and Bisson 1992).

Some detrital input into streams also originates from beyond the immediate streamside. Detrital input to streams can originate from upstream areas. Richardson (1992) estimated that 70-94 percent of all leaves that enter a stream segment are transported downstream, until likely stored in a large pool or lake. Gregory et al. (1987) indicated that the greater the roughness elements of a stream, the greater the retention of detrital input. Thus, areas having large amounts of existing debris tend to retain more of the additional detrital input. This finding suggests that some detrital input from upper headwater areas that may not have fish likely contributes to lower downstream segments that support fish. The overall importance and magnitude of this upstream contribution to detrital input is not known.

No studies have been conducted to specifically determine the horizontal distance within which allochthonous detritus is input to streams (FEMAT 1993), but it has been estimated that 14-25 percent of the total litter input to a stream can originate from along the banks due to wind action alone (Richardson 1992). Newbold et al. (1980) found that diversity, a measure of aquatic insect community health, was high in streams with buffer strips at least 30 meters (100 feet) wide. According to Figure V-12 in FEMAT (1993), approximately 90 percent of the litter fall to streams occurs within half a site potential tree height from the stream, or about 33 meters.

ALTERNATIVE A

Under Alternative A the majority of Type 1 and 2 Waters would receive sufficient buffering to protect detrital production. Type 3, 4, and 5 Waters, however, would receive, on average, less than the 100 feet suggested by the literature (FEMAT 1993 Figure 12) for total protection of detritus input. In some cases where no minimum zone width is specified, such as in Type 4 and 5 Waters, buffers may not provide sufficient detrital production protection for many years. Without sufficiently wide riparian management zones, the detritus materials that come from the adjacent forest canopy would no longer supply the stream with an energy base. This could be an important impact during the initial years after logging, at least until the riparian canopy could regrow.

The natural mix of deciduous and coniferous detritus is a vital part of the energy cycle in small forested streams. The deciduous material provides short-term energy and the coniferous material provides long-term energy. The riparian forest is an important regulator of stream productivity through the amounts and qualities of material directly contributed to the stream. In some cases, the source of woody material to stream channels is lost for decades, until a new forest can regrow. During the interim period, the composition of woody inputs shifts from coniferous material, which is relatively decay-resistant, to deciduous material, which is more rapidly decomposed.

ALTERNATIVE B

Riparian management zones provided on Type 1 through 4 Waters under Alternative B meet the widths recommended by the literature (100 feet) for detritus production protection. These widths would provide continuous inputs of detritus to the streams, and would allow the maintenance of stream productivity in both the short and long term. The amount of detrital production that comes from Type 4 and 5 Waters is not well documented, however, it is probably an important portion of the overall productivity. Under Alternative B the protection provided on Type 5 Waters in unstable areas will meet most recommended detrital input needs; but this may not be the case for Type 5 Waters on stable ground because they will not receive riparian management zone protection. Because of the lack of riparian management zone protection along these streams, it is possible that there will be an interruption of detritus input until the riparian forest regrows to the point of canopy closure.

Because the riparian management zone closest to the stream would be a no-harvest area, except for ecosystem restoration, maintenance of detrital inputs will occur because the riparian management zone will remain in a relatively productive condition. Ecosystem restoration activities in the minimal-harvest area, occurring 25-100 feet from the active channel, would not appreciably reduce the ability of the riparian management zones to contribute detrital nutrients. The remaining portion of the riparian management zone (more than 100 feet from the active channel margin) is beyond the width necessary to protect detrital inputs.

The provision of a 100-foot-wide wind buffer on the windward side of Type 1, 2, and the larger Type 3 Waters will provide additional protection for the riparian management zone, ensuring that detrital inputs would be maintained.

Alternative B provides more consistent protection of detrital inputs than Alternative A, because of the wider riparian management zones left on all water types, and the limited harvest activity allowed within the riparian management zones. The provision of additional wind buffers on the windward side of the riparian management zones would further decrease the risk of blowdown, and thus increase the ability of the riparian management zones to provide detritus production protection.

ALTERNATIVE C

The riparian management zones provided along all water types will be sufficient to maintain the detrital inputs on all streams at or near natural conditions. The provision of wind buffers on Type 1, 2, and larger Type 3 Waters will further protect the integrity of the riparian management zones. The 25-foot-wide no-harvest area immediately adjacent to all stream types, and the limited activity area in the rest of the riparian management zone, will ensure full protection of detrital inputs.

Alternative C would provide more protection of detrital input rates than Alternative A on all water types. Unlike Alternative A, Alternative C would provide a wind buffer on both sides of the riparian management zones on Type 1, 2, and larger Type 3 Waters. Under Alternative C, Type 3 Waters less than 5 feet wide, Type 4 Waters, and most Type 5 Waters would receive more detritus protection than is provided under Alternative A; however, some Type 5 Waters in stable areas would not receive protection.

Large Woody Debris (LWD)

Numerous studies have shown that large woody debris (LWD) is an important component of fish habitat (Swanson et al. 1976; Bisson et al. 1987; Hicks et al. 1991; Naiman et al. 1992). Trees and other large pieces of wood that fall into streams provide critical physical and biological functions in streams (Swanson and Leinkaemper 1978, 1982; Bisson et al. 1987; Sedell et al. 1988; Maser and Sedell 1994). These functions relate to sediment retention (Keller and Swanson 1979), gradient modification (Bilby 1979), channel structural diversity (Ralph et al. 1994), stream nutrient production (Cummins 1974), and escape cover (Bisson et al. 1987; Bilby and Ward 1989). Large woody debris also plays an important role in retaining salmon carcasses in streams, where they are consumed by a variety of wildlife scavengers and contribute to aquatic productivity (Cederholm and Peterson 1985; Cederholm et al. 1989; Bilby et al. in press).

Buffer zones are critical in maintaining LWD input to streams in areas intensively managed for timber harvest. Post-harvest LWD recruitment levels have relatively long recovery rates of up to 250 years (Murphy and Koski 1989; Grette 1985). Based on a study by Murphy and Koski (1989), the buffer zone width recommended to maintain adequate LWD is approximately 30 meters (100 feet). However, this study was carried out in Alaska where the tallest trees are not as large as those found in Washington. McDade et al. (1990) estimated that for old-growth conifer forests in Oregon, 50 percent of debris originates within 10 meters (33 feet) of the stream, 85 percent within 30 meters (100 feet), and 100 percent within 50-55 meters (165-182 feet). For mature hardwoods, they estimated that 100 percent of LWD originates within 25 meters (83 feet) of the stream. Van Sickle and Gregory (1990) presented a general model of LWD input to streams that shows that the majority of LWD originates within relatively short distances from the stream. Maintaining 100 percent of available LWD input into streams requires buffer widths approaching total tree height, and the rate of LWD input for streams changes with increasing distance away from the stream (FEMAT 1993 Figure V-12; McDade et al. 1990). Based on this figure, approximately 90 percent of the LWD input occurs within a distance of 80 percent of a site potential tree height from the stream, or about 50 meters (155 feet). Cederholm (1994) reviewed the literature on maintenance of

LWD input for salmon streams and found that the distance needed for 100 percent recruitment potential averaged 47 meters (155 feet).

In addition to the amount of LWD input, the species of LWD contributed is also important. Coniferous LWD significantly outlasts deciduous LWD in the stream system (Harmon et al. 1986; Bisson et al. 1987) and can remain in stream channels for 200 years or longer (Swanson et al. 1976; Keller and Tally 1979; Grette 1985). Thus, simply setting aside buffers of second-growth hardwoods (which comprise a large proportion of the streamside vegetation on DNR-managed lands) does not provide optimal LWD input over the short term because unassisted recovery of these areas to pre-logging coniferous LWD recruitment levels may take hundreds of years.

Although the specific role of Type 4 and 5 Waters in LWD input to downstream areas is not completely understood, these streams are known to supply some LWD to the larger downstream salmon-bearing waters (Potts and Anderson 1990). The role of LWD in Type 4 and 5 Waters is partly one of stabilizing existing debris and sediment to maintain rates of sediment routing at near natural levels.

Regional differences in LWD loading in unmanaged forests apparently exist. However, due to lack of site-specific stream survey information and the wide variability of data within regions, limited comparison of LWD loading could be evaluated at this gross level of analysis. A systematic study to determine regional differences in LWD loading has not been conducted. Although not well documented, some differences in LWD loading between geographic regions can be found in the literature. Bilby and Ward (1991) found approximately 200 pieces of LWD per 500 meters (1,650 feet) of stream in unmanaged stands in southwestern Washington. This contrasts with an average of 300 pieces (95 percent confidence interval = 200-400) per 500 meters (1,650 feet) of stream in old-growth forests of the Olympic Peninsula (Grette 1985), and an average of 313 pieces per 500 meters (1,650 feet) of recently managed tributaries of the Hoh River (C. J. Cederholm, DNR, Olympia, WA, unpubl. data, 1996). It is important to realize that LWD loading rates can vary widely between and within drainages of similar size, gradient, and logging history.

ALTERNATIVE A

The riparian management zones left on Type 1 and 2 Waters could provide a high degree of protection of future LWD loading, because they average 196 feet wide. However, some riparian management zones could end up being much smaller than average, due to the minimum 40 foot widths provided under this alternative. Riparian management zone widths on Type 3 Waters would only provide a portion of the LWD needs, because the zone widths average 85 feet wide. This alternative would allow timber harvest for commercial purposes in the riparian management zones and this removal might result in decreased LWD input rates over the short and long term. This could have a cumulative effect on future LWD loadings because of an eventual slowdown in LWD inputs in future years. Because there is no minimum riparian management zone width designation on Type 4 and 5 Waters under this alternative, some streams could receive no riparian management zone protection.

The lack of specifically applied wind buffers under Alternative A increases the risk that riparian management zones may blow down. This would result in a short-term input of LWD, but in the long term the LWD input would reduce to a low level until the forest regrows.

ALTERNATIVE B

Alternative B specifies a minimum riparian management zone width of 100 feet on Type 1 and 2 Waters. This alternative would exceed the LWD protection provided under Alternative A in many cases. When compared to Alternative A, it is anticipated that Alternative B would allow very limited timber removal from the riparian management zone and therefore more trees would be available as LWD trees. The reason for this limited removal is to maintain or restore the quality of salmon habitat. In areas prone to blowdown, riparian management zones left along Type 1 and 2 Waters would receive additional 100-foot wind buffers on the windward side of streams. These riparian management zones would therefore have a high probability of maintaining the short- and long-term LWD inputs because they would be protected from blowdown.

Type 3 Waters would receive more, and consistently wider, riparian management zones than under Alternative A. Type 3 Waters wider than 5 feet would receive 50-foot wind buffers on their windward sides, and these wind buffers would protect the riparian management zones from damage, thus ensuring that they would provide LWD inputs over time. Type 4 Waters would receive 100-foot riparian management zones, which are less than the one site potential tree height recommended by the literature; but, because this is a minimum width, all streams would receive at least this much protection. This size of riparian management zones on Type 4 Waters is sufficiently wide to provide most LWD inputs over time. Type 5 Waters would receive riparian protection where necessary, according to the Forest Resource Plan Policy No. 20 (DNR 1992b).

The 25 feet of the riparian management zone closest to the stream would be a no-harvest area. Any ecosystem restoration or single-tree selective harvest activities occurring between 25 and 100 feet from the active channel would not appreciably reduce the ability of the zone to contribute LWD. The remaining portion of the riparian management zone in the case of Type 1, 2, and 3 Waters is a low-harvest area, and additional LWD contributions would be provided from this area.

Alternative B provides for more LWD inputs than Alternative A because it provides wider riparian management zones on the smaller Type 3 and 4, Waters. This alternative also provides a wind buffer on the windward side of Type 1, 2, and larger Type 3 Waters in blowdown-prone areas, and allows less harvest activity within the riparian management zones. The provision of additional wind buffers in Alternative B decreases the risk that the riparian management zones may blow down, and thus increases their ability to provide LWD input over time.

ALTERNATIVE C

The riparian management zones on Type 1 through 5 Waters would ensure most LWD recruitment is maintained on all streams. The provision of 100-foot wind buffers on both sides of the riparian management zones on the Type 1, 2, and larger Type 3 Waters would decrease the risk that riparian management zones may blow down and lower the LWD protection.

A 25-foot-wide area immediately adjacent to the stream would be a no-harvest area, and from there to the outer edge of the protected zone, activities would be allowed only if serving to restore and/or enhance the function of the riparian management zone. This will provide protection of LWD recruitment potential in almost all cases.

Alternative C is more protective of LWD inputs than Alternative A because it leaves sufficiently wide riparian management zones on all water types, allows very limited harvest activity within the riparian management zones, and provides a wind buffer on both sides of Type 1, 2, and larger Type 3 Waters.

Windthrow

Windthrow of entire trees occurs when wind forces overcome the rooting strength in the soil, tipping over the tree, its root ball, and some amount of root-attached soil (Coutts 1986). Windbreak, a type of windthrow, occurs when applied wind forces overcome stem strength somewhere above the root ball, breaking the stem and tipping over some percentage of the total tree height. Wind force is transferred to trees by the resistance they provide to wind flow (i.e., drag). Windthrow is a normal occurrence in forests but is known to increase after timber harvest opens formerly interior forest trees to the more direct effects of the wind (Harris 1989). Buffer strips along streams are subject to similar increases in windthrow. Though windthrow and buffer strip stability have not been studied extensively, several pertinent studies exist for the Pacific Northwest (Steinblums 1977; Steinblums et al. 1984; Andrus and Froehlich 1986; Rot 1993; Mobbs and Jones 1995).

In the Pacific Northwest, the strongest and most damaging winds are associated with fall and winter windstorms approaching the coast from the southwest (Canada. Environment Canada 1992). These high wind storms are commonly associated with heavy precipitation. The combination of high winds and wet soil conditions increases the potential for windthrow (Harris 1989). The strongest wind systems, known as superstorms, also originate from the southwest, usually between October and February (Renner 1993). These storms can produce gusts of greater than 100 miles per hour. The three best known superstorm occurrences are the Great Olympic Blowdown of January 1921, the Columbus Day storm of 1962, and the Inauguration Day storm of 1993 (Kruckeberg 1991; Renner 1993). The Great Olympic Blowdown storm had winds of 113 miles per hour with gusts apparently reaching 150 miles per hour (Kruckeberg 1991). Winds exceeding 80 miles per hour occurred in Puget Sound during the two later storms (Renner 1993). In the Columbus Day storm, almost 10 billion board feet of timber were blown down (Kruckeberg 1991).

A combination of high winds and heavy snowfall can also influence windthrow. This combination of factors can occur with southwest storms, but is primarily associated with cold winter storms or arctic outbreaks that originate from the interior of British Columbia (Canada. Environment Canada 1992; Renner 1993). These arctic outbreaks are often associated with strong wind systems found in the valleys of the Fraser and Squamish Rivers in British Columbia (Canada. Environment Canada 1992). Such storms would most likely influence the east Olympic Peninsula and north Cascade regions, though their effect can reach as far as the Willamette Valley in Oregon. These storms are short-lived, generally lasting only a day or two (Renner 1993). With cold storms of longer duration, the soil is more likely to be frozen, which may increase soil resistance and reduce windthrow (Moore 1977).

Topographic channeling or directing of winds is also an important influence on wind direction and windthrow. On a broad scale, wind channeling is evident in the Columbia River valley, the Chehalis River valley (E-W winds), central Puget Sound (N-S winds) and along the Strait of Juan de Fuca (E-W winds) (Phillips and Donaldson 1972; Canada. Environment Canada 1992; Renner 1993). On a local scale, wind channeling is evident in individual valleys based on observed windthrow directions (Andrus and Froehlich 1986; Rot 1993). Winds may also be constricted as they move through a valley in a process called funneling (Canada. Environment Canada 1992; Renner 1993). Such constriction causes a Bernouli effect and the winds accelerate, perhaps to twice their initial speed (Renner 1993).

On a very local scale, down-valley winds may occur. These winds usually occur when air near the ground cools at night, becomes more dense than the air above it, and then drains down the valley (Renner 1993). Such winds are documented at Mt. Rainier (Buettner and Thyer 1962) but are not known to produce significant amounts of windthrow.

Steinblums (1977) and Steinblums et al. (1984) evaluated 40 streamside buffer strips in old-growth forest in the Cascade mountains of western Oregon. Logging had occurred at these sites between 1 and 15 years prior to data collection. Stability in these buffer strips ranged from 22-100 percent of initial gross volume. Windbreak was minor. Steinblums et al. (1984) established a relationship between site parameters and the timber volume remaining in buffer strips. The important parameters were slope distance from the outer edge to uncut timber in the direction of damaging wind, change in the elevation from the midpoint of the buffer to the top of the nearest major ridge in the direction of the wind, the horizontal distance from the outer buffer edge to the top of nearest major ridge in the direction of the wind, the direction of stream flow in relationship to damaging winds, the elevation of the buffer strip at its midpoint, a visual estimate of stability, and a measure of the site's soil moisture.

Andrus and Froehlich (1986) evaluated 30 streamside buffers in second-growth forests in the western part of the Oregon Coast Range. Logging had occurred at these sites between 1 and 6 years prior to data collection. Thirteen buffers (43 percent) were in stands between 50 and 75 years old, and 17 buffers (57 percent) were in stands between 80 and 140 years old. The basal area of snapped and uprooted trees ranged from 0-72 percent of the total original basal area of the buffer strips. Damage was greater than 20 percent at 13 sites (43 percent of total sites). At nine sites greater than one-third of the trees were damaged by windbreak. The damaging wind direction was from the southwest. The direction of windthrow was northeast on the windward side of the buffers, but on their leeward side the direction of windthrow ranged between northwest and northeast. The wider range on the leeward side indicates that variable winds due to turbulence were more of a factor at these locations. Additionally, when the sites were examined individually the direction of damaging winds was wider, ranging from S75E to N60W. At only 14 of 26 sites (54 percent) did the most common direction of tree fall indicate that the most damaging winds were from the southwest. This observation indicates that topographic funneling of winds can be an important factor in windthrow.

Andrus and Froehlich (1986) found that four site characteristics accounted for 57 percent of the variability in windthrow. These site characteristics were: (1) percentage of live trees in the initial buffer stand that grow on boggy terraces; (2) percentage of basal area in the initial stand that is conifer; (3) general orientation of the stream segment with respect to southwesterly winds (S45W); and, (4) the shape of the hillslope in the direction S30W or S60W from the midpoint of the stream segment.

Andrus and Froelich (1986) also noted that only 12 percent of windthrown trees were sources of accelerated sedimentation to the adjacent stream. The sediment source was the upturned root wad. Compared to estimated natural sediment yields in these basins, the additional sediment influx ranged from 1-21 percent. Only seven sites had sediment yield increases greater than 1 percent. Additionally, Andrus and Froelich (1986) did not find any accelerated mass wasting associated with these windthrown trees or their associated upturned root wads.

Rot (1993) analyzed 14 stream buffers along Type 1 and 3 Waters on the southwestern Olympic Peninsula north of Hoquiam in Grays Harbor County, Washington. Logging at these sites had occurred less than 5 years prior to data collection. These stands were second growth between 53 and 143 years old. Five Type 1 and nine Type 3 stream buffers were evaluated with 6 percent and 35 percent windthrow found in the buffers for Type 1 and 3 Waters, respectively. These values are percentages of trees left following harvest. Windbreak was not measured separately but was included in the windthrow total.

Rot (1993) found that the strongest winds were from the southwest (between S and S60W) and accounted for 51 percent of the windthrow. Winds originating from the south to west (S30E to W) accounted for 75 percent of the windthrow. He defined three types of riparian topography: Type A - narrow alluvial flats (50-200 feet wide) with upland slopes greater than one tree height high and less than two tree heights wide, Type B - steep sideslopes greater than 15 feet high with a 5- to 20-foot-wide stream in the valley bottom, and Type C - flat riparian and upland topography. Buffers in Type B riparian topography were the most windfirm with 20 percent windthrow compared to approximately 50 percent windthrow in Types A and C. He found that the most windfirm buffers had upwind topography that was at least one tree height higher than the buffer and less than two tree lengths in distance from the buffer to the slope crest.

Soil moisture is another important variable affecting windfirmness (Rot 1993). Windthrow was higher for conifers rooted near the stream in wetter areas than for those rooted well above the stream, either on higher terraces or on the hillside. The higher terraces seem to be above the ground water table. Trees near the bottom of steep valley sides appeared to be rooted in wetter sites caused by ground water concentration at the base of slopes. Rot (1993) noted that the windfirmness of Type 1 Waters was partially due to their southwesterly flow direction, i.e., they flowed into the prevailing wind. Similarly, Type 3 Waters with their buffers aligned parallel to the southwesterly winds had a lower percentage of windthrow than Type 3 Waters with their buffers aligned perpendicular to the southwesterly winds.

Mobbs and Jones (1995) analyzed 90 riparian management zones on Type 1 through 4 Waters in coastal western Washington from the Queets River basin south to the Chehalis River basin. The area included three DNR administrative regions and six counties. The sites were sampled within 1 year of harvest. Windthrow was totaled as a percent of total live trees. Total windthrow as a percent of total leave trees by water type was: (1) Type 1 Water - 3.3 percent; (2) Type 2 Water - 3.2 percent; (3) Type 3 Water - 6.2 percent; and, (4) Type 4 Water - 8 percent. They found that windthrow as a percent of total leave trees by riparian management zone orientation was: (1) 2.4 percent for north-to-south riparian management zone orientation; (2) 4.5 percent for east-to-west riparian management zone orientation; (3) 4.9 percent for northeast-to-southwest riparian management zone orientation; and, (4) 7.0 percent for northwest-to-southeast riparian management zone orientation. Windthrow was significantly higher on Type 4 Waters than for all other water types.

Steinblums et al. (1984) and Andrus and Froehlich (1986) found no significant correlation between buffer width and the amount of windthrow. Rot (1993) found a very weak relationship between buffer width and windthrow (correlation coefficient of 0.33 for standing live trees and 0.31 for windthrow). Mobbs and Jones (1995) present plots of percent windthrow versus average buffer width that suggest there is less total windthrow in wider buffers, though this relationship was not quantified. This relationship is weak to moderate because windthrow is generally concentrated at the buffer edge no matter how wide the buffer actually is. Andrus and Froehlich (1986) cite that Gratowski (1956) found windthrow concentrated in the first 50 feet of a harvest unit edge, and that in each successive 50-foot segment windthrow diminished by approximately one-half. Rot (1993) cites that Gratowski (1956) found windthrow extended up to approximately 200 feet from the old-growth harvest unit boundaries.

Fall and winter winds approaching from the southwest are the dominant cause of significant windthrow. Topographic channeling and funneling may also produce localized winds capable of windthrow. No study documents regional variability in windthrow, however, it is likely that local windthrow variability is greater than regional variability in western Washington. Therefore, all regions were considered to have an equal windthrow potential.

Adding wind buffers to the outside of riparian management zones is as yet an untested idea; however, it is felt that the additional width of some blowdown-prone riparian management zones would help protect the interior riparian habitat components.

ALTERNATIVE A

There would be no provision for wind buffers along any water types. As a result, there is a high risk that the integrity of the riparian management zones will be lost due to blowdown in some areas.

ALTERNATIVE B

Alternative B provides wind buffering on the windward side of the Type 1, 2, and larger Type 3 Waters in areas of high blowdown potential. This would increase the likelihood of the riparian management zone functioning to provide salmonid habitat protection over the long term. Harvest activity in the wind buffers would have the objective of increasing the windfirmness of the interior riparian management zone.

The unpredictability of choosing where and when to leave a wind buffer may be a problem in this alternative. It would, however, protect the interior riparian management zone from blowdown in many cases and thus provide increased protection when compared to Alternative A.

ALTERNATIVE C

The application of wind buffers on both sides of Type 1, 2, and larger Type 3 Waters would reduce error in the placement of wind buffers that might occur based on the misinterpretation of local wind direction. Wind buffers applied to both sides of streams would also tend to displace windthrow further from the stream, protecting the riparian management zone from both the direct impacts of wind on the windward side, and indirect effects of wind from turbulence on the lee side of buffers. This should result in more consistent protection of the integrity of the riparian management zone.

Alternative C gives more protection to salmon habitat than Alternative A because it leaves a wind buffer on both sides of the riparian management zone on the Type 1, 2, and larger Type 3 Waters and this buffer will further ensure that the riparian management zones are functioning as intended over time.

Water Temperature

Changes in water temperature and light regime have both positive and negative consequences for salmonid production and are often difficult to predict. Removal of streamside vegetation allows more solar radiation to reach the stream surface, increasing water temperature and light availability (Brown and Krygier 1970; Meehan 1970; Beschta et al. 1987; Bisson et al. 1988a). The interpretation of much of the early research on water temperature changes induced by logging was that these alterations were predominantly harmful to salmonids (Lantz 1970).

Water temperature increases can be expected to influence embryonic, juvenile, and adult salmonids in small streams (Hicks et al. 1991). It is likely that effects during the time that juveniles are rearing in freshwater are the most significant. Temperature increases can also affect fish survival by increasing the virulence of many diseases, modifying the effects of toxic materials (Lantz 1970), and lowering the amounts of oxygen available to salmonids.

The upper and lower limits of temperature tolerance in fish can be extended through both adaptation and resistance (Fry 1947). Brett (1952) reported that more time was needed for acclimation to low temperatures than to high temperatures. He also determined the lethal limits for high and low water temperatures for the young of all species of Pacific salmon using a range of acclimation temperatures. Coho and chinook salmon were the most tolerant of high temperatures although no species could tolerate temperatures exceeding 25.1 degrees C (77.2 degrees F) for exposure times of 1 week. Work by Bisson et al. (1988a) under highly unusual conditions in tributaries of the Toutle River (within the blast zone of the volcano at Mt. St. Helens, Washington) documented juvenile coho salmon rearing in summer water temperatures up to 29.5 degrees C (85.1 degrees F). This was a situation of planted hatchery coho in a stream with no other fish community present. These were determined to be the highest water temperatures ever recorded with coho salmon-rearing populations in Washington streams.

Forest canopy removal has resulted in increased winter temperatures in some coastal drainages of the Pacific Northwest (Beschta et al. 1987). Slight post-logging increases in late-winter water temperatures were found in Carnation Creek, a coastal stream on Vancouver Island, British Columbia (Hartman et al. 1987; Holtby 1988). These temperature increases led to accelerated development of coho salmon embryos in the gravel and earlier emergence of juveniles in the spring. Earlier emergence resulted in a prolonged growing season for the young salmon but also increased the risk of downstream fry displacement during late-winter freshets. The increased fry displacement resulted in underseeded conditions during some years. The juveniles that were able to survive to the rearing stage had a higher proportion of 1-year old smolts rather than the normal high proportion of 2-year olds. Using a marine survival model developed by Bilton et al. (1982), marine survival is expected to decline sharply as the fish are still smaller than the normal 2-year olds.

Adult salmon and trout respond to stream temperatures during their upstream migrations (Bjornn and Reiser 1991). Delays in upstream migration due to excessively warm natal streams have been observed for sockeye salmon (Major and Mighell 1966), chinook salmon (Hallock et al. 1970), and steelhead (Monan et al. 1975). Bell (1986) reported that Pacific salmon and steelhead have migrated upstream at temperatures between 3 and 20 degrees C (37.4 to 68 degrees F).

Salmonids are most metabolically efficient within the range of 12-14 degrees C (53.6-57.2 degrees F); 10-13 for steelhead (50-55.4 degrees F), and growth is reduced at higher and lower temperatures (Bjornn and Reiser 1991). Growth ceases for coho when temperatures exceed 20.3 degrees C (68.5 degrees F) (Reiser and Bjornn 1979; Brett 1952). At temperature extremes, fish not only do not have the energy to acquire food, but they also cannot digest it. The capacity for work, including swimming, declines and fish will eventually starve to death if they do not succumb to some other cause first (Beschta et al. 1987).

Competitive interactions will be affected by temperatures in several ways: Elevated temperatures may increase competition as fish "pack" into cooler areas to avoid high temperatures. In cohabiting situations, Reeves et al. (1987) found that steelhead were dominant in cooler temperatures, while redsided shiners (a highly competitive non-salmonid fish) were dominant at temperatures above 19 degrees C (66.2 degrees F).

Streams can be too cold as well as too warm for upstream-migrating salmonids (Bjornn and Reiser 1991). Cutthroat and rainbow trout have been observed waiting for tributaries to warm in spring before entering them to spawn. Adult steelhead that return from the sea in summer and spend the winter in inland rivers before spawning in spring, overwinter in large rivers downstream from their natal streams because the smaller headwater streams are often ice-choked during winter. It is believed that steelhead overwinter in the larger rivers because survival rates are higher there and the slightly higher temperatures in the rivers enable timely maturation (Reingold 1968).

The Washington Department of Ecology maximum temperature standards for waters impacted by human activities are 16.3 degrees C (61.3 degrees F) for Class AA waters and 18.3 degrees C (64.94 degrees F) for Class A waters. Class AA and A waters encompass nearly all forested streams in the state.

The forest canopy is typically evaluated by considering the angular canopy density (ACD). In contrast to canopy closure, which measures canopy density projected to a horizontal surface, ACD is the projection of canopy closure at the angle at which solar energy passes through the canopy to the stream. In areas intensively managed for timber harvest, maintaining vegetation buffers along the stream banks is an effective way to maintain stream temperatures at levels appropriate for fish and other aquatic organisms.

Specific approaches for managing riparian vegetation to protect water temperature in western Washington are provided by Sullivan et al. (Timber/Fish/Wildlife Temperature Work Group 1990) and Caldwell et al. (1991) and are summarized in the watershed analysis training manual (WFPB 1995b). These sources identified a number of important considerations relative to protection of stream temperature, including: (1) non-fishbearing waters that contribute 20 percent or more of the volume of fishbearing Type 1, 2, or 3 Waters significantly influence water temperature; (2) water temperature reaches equilibrium with local conditions once streams have traveled for approximately 1,000 feet (305 meters) through a zone of uniform canopy closure; (3) in western Washington, at elevations greater than 3,600 feet (1,098 meters), stream temperature is unlikely to exceed temperature standards, even when timber harvest activities occur; (4) target shade requirements vary with water type and elevation; and, (5) for Type 1, 2, and 3 Waters, total stream shading of 50-75 percent is generally required to maintain streams within water quality standards.

Water temperatures in Type 4 and 5 Waters are more sensitive to changes in streamside shading than Type 1, 2, and 3 Waters downstream (Timber/Fish/Wildlife Temperature Work Group 1990). Cumulative downstream effects of increased temperatures in headwater tributaries have not been documented. It would be expected that, assuming similar amounts of ground water inflow into lower streams, the proportion of Type 4 and 5 Waters in a watershed may affect overall downstream water temperature sensitivity in that planning unit.

Rashin and Graber (1992) evaluated the effectiveness of best management practices (BMPs) for protecting water temperatures in streams in western Washington. The riparian management zones studied were narrow and included some partial cutting. The riparian management zone buffers were considered ineffective on many of the streams that were studied, particularly those with losing reaches (i.e., stream discharge loss to ground water) and beaver ponds. Rashin and Graber (1992) also evaluated the methods of Sullivan et al. (Timber/Fish/Wildlife Temperature Work Group 1990) and considered their methods to offer major advantages because the methods included parameters such as site elevation and riparian shade. If watershed analysis procedures and requirements (WFPB 1995b) alone are implemented, a low to moderate level of protection for water temperature is anticipated.

Buffer strips approximately 30 meters (100 feet) wide are believed to shade the stream to the same extent as old-growth forests which typically have ACDs of 80-90 percent (Beschta et al. 1987). Other studies, summarized in Johnson and Ryba (1992), generally recommend a similar buffer width of approximately 29 meters (96 feet) to protect stream temperature. If the buffer is less than 30 meters (100 feet), or if the buffer is selectively logged, considerations such as species composition, stand age, and vegetation density become important (Beschta et al. 1987).

The sensitivity of streams to changes in water temperature may vary regionally. Such regional differences in temperature sensitivity are due to a number of factors including elevation (Rashin and Graber 1992), proportion of Type 4 and 5 Waters and proximity to the coast (Timber/Fish/Wildlife Temperature Work Group 1990). Because stream temperature decreases with increased elevation, streams at higher elevations are expected to be cooler and less influenced by shade levels than downstream areas. Proximity to the coast may also influence geographic variation in stream temperature although relationships are poorly defined. Data in Sullivan et al. (Timber/Fish/Wildlife Temperature Work Group 1990) suggest that coastal streams tend to have higher summer temperatures than streams on the west slope of the Cascades. However, since data on streams with equivalent shading, elevation, and flow are limited, this trend should be considered weakly supported.

The number and type of wetlands in a watershed may also influence stream temperature, particularly during low-flow periods, by augmenting stream flow with cool ground water or well-shaded surface water from wetland outlets and subsurface flow.

ALTERNATIVE A

Type 4 and 5 Waters would not always receive adequate protection because the lower end of the range of buffer widths would be zero. Roughly 50 percent of Type 5 Waters would receive riparian management zones averaging 40 feet (range 0-150 feet) in width and the other half would not receive a riparian management zone. The lack of specifically applied buffers to protect them from windthrow would increase the risk that riparian management zones would blow down, reducing their ability to provide shade protection.

ALTERNATIVE B

Riparian management zones on Type 1, 2, and 3 Waters would equal the height of one site potential tree, wider than the widths recommended in the literature to protect stream shading. Type 4 Waters would receive riparian management zone widths of at least 100 feet on each side of the streams, well within the range recommended by the literature. Type 1, 2, and larger Type 3 Waters would also receive a wind buffer on the windward side of the stream, further protecting the riparian management zone in blowdown-prone areas.

All Type 5 Waters in areas of unstable slopes would receive riparian management zone protection; those in stable terrain would not.

The 25 feet of the riparian management zone closest to the stream is a no-harvest area, and this zone will contribute to water temperature protection. It is anticipated that only ecosystem restoration activities would occur in this area. Activities occurring between 25 and 100 feet from the active channel would not appreciably reduce stream shading. It is anticipated that only two types of silvicultural activities will occur in this area: ecosystem restoration and single-tree selective harvest. The remaining portion of the riparian management zone (more than 100 feet from the active channel margin) would be a low-harvest area, and the low harvest activity in this area will further ensure water temperature protection.

Because Alternative B states riparian management zone width of one site potential tree height and a 100-foot minimum width riparian management zone on Type 1, 2, and 3 Waters, these waters would receive consistently greater shade protection than under Alternative A. Alternative B does a better job of protecting the shading of Type 4 Waters, because it designates a minimum width 100-foot riparian management zone, while Alternative A riparian management zones specify an average and do not designate a minimum width. Additionally, in blowdown-prone areas, Alternative B adds a 100-foot wind buffer on the windward side of Type 1 and 2 Waters and a 50-foot wind buffer on the windward side of the larger Type 3 Waters, and this further ensures that the riparian management zones along these streams will provide shade protection.

ALTERNATIVE C

The riparian management zones on each side of Type 1 through 5 Waters would be consistently wider than the widths recommended in the literature for water temperature protection. The 100-foot wind buffers would be provided on either side of Type 1 and 2 Waters and 50-foot wind buffers on either side of Type 3 Waters greater than 5 feet wide, further ensuring water temperature protection.

The 25-foot wide area immediately adjacent to the stream would be a no-harvest area. From there to the outer edge of the protected area, activities would be allowed only if the activity serves to restore and/or enhance the water temperature protection function.

All water types would receive significantly greater shade protection under Alternative C than under Alternative A, because Alternative C designates riparian management zone widths that are well within the acceptable range of literature recommendations and allows relatively little harvest in the riparian management zones. Alternative C also adds a 100-

foot wind buffer on each side of Type 1 and 2 Waters and a 50-foot wind buffer on each side of the larger Type 3 Waters, which further ensures the water temperature protection function.

Sediment

Timber harvest activities often alter watershed conditions by changing the quantity and size of sediment supplied to streams. Such activities can lead to stream channel instability, pool filling by coarse sediment, or the introduction of fine sediment to spawning gravel. Factors influencing the excessive delivery of sediment to a stream include the intensity and location of erosion and mass-wasting events and the presence of adequate vegetated buffers to filter fine sediment derived from hillslope and road erosion (Hicks et al. 1991; Everest et al. 1987).

Though increased sediment yields can originate from either the banks or beds of destabilized streams (Megahan 1982; Scrivener 1988), the major upland source of coarse and fine sediments is landslides from road prisms and steep harvested hillsides (Reid 1981; Schlichte et al. 1991; Chamberlin et al. 1991). Coarse sediment derived from hillslope and road prism failures can enter high-gradient Type 4 and 5 Waters and be transported directly downstream to Type 1, 2, or 3 Waters. Erosion from road surfaces can also be a major source of fine sediment (Reid 1981; Cederholm and Reid 1987; Beschta 1978; Furniss et al. 1991). A clearcut on an unstable slope increases the likelihood of landslides (Swanson and Dyrness 1975; Swanson et al. 1987). Landslides resulting from timber harvest are considered a significant source of sediment input into streams (Wu and Swanson 1980; Chesney 1982; Everest et al. 1987; Sidle 1985). In the Pacific Northwest, roads appear to cause more landslides than clearcutting; however, this pattern varies substantially among areas (Sidle et al. 1985), and seems to be highly dependent on watershed characteristics (Duncan and Ward 1985).

Typically, landslides occur when local changes in the soil pore water pressure increase to a degree that the friction between soil particles is inadequate to bind them together and the soil slides downslope under the force of gravity. Timber harvest affects the local soil pore water pressure in at least two ways. First, transpiration is decreased with tree removal. Decreased transpiration increases soil moisture, thus increasing the risk of slope failure. Second, since the forest canopy intercepts precipitation, the amount of precipitation reaching the forest floor per unit time increases after harvest, and this too causes an increase in soil moisture. Also, tree harvest ultimately results in the decay of tree roots. Living tree roots add strength to the soil, but as roots decay this strength is lost and the likelihood of landsliding increases until new root systems are established.

Road-caused erosion in upland areas can have significant detrimental impacts to salmonid habitat in downstream areas (Hicks et al. 1991). Only rarely can roads be built that have no negative effects on streams (Furniss et al. 1991). Roads are a major source of management-related sedimentation in streams (Cederholm and Reid 1987). The contribution of sediment per unit area from roads is often greater than that from all land management activities combined (Furniss et al. 1991). In northern coastal California, haul roads and tractor skids were found to alter the drainage network and sediment yield of water basins (Swanson et al. 1987). Cederholm et al. (1981b) reported a significant positive correlation between fine sediment in spawning gravels and the percentage of basin area with roads. Forest roads can increase the incidence of mass soil movements (i.e., landslides) by 30-300 times as compared to undisturbed forests (Furniss et al. 1991).

Sediment that settles in streams or moves in suspension can reduce salmonid viability (Hicks et al. 1991). Fine sediment deposited in spawning gravel can reduce interstitial water flow, leading to depressed dissolved oxygen concentrations, and can physically trap emerging fry in the gravel (Koski 1966; Meehan and Swanston 1977; Everest et al. 1987). Survival of coho salmon in natural and simulated redds (spawning nests) is related to the proportion of fine particles in the gravel (Koski 1966, 1975; Tagart 1976).

Studies in coastal drainages on the Olympic Peninsula of Washington have addressed the effects of sediment on coho salmon spawning gravel (Tagart 1976; Cederholm and Reid 1987). These studies concluded that sediment can lower the smolt yield in some years of low spawner abundance. The concentration of intragravel fine sediment in spawning riffles was positively correlated with the extent of logging road mileage in the watersheds. The negative effects of sedimentation on coho salmon spawning success was estimated by monitoring the survival of embryos and fry in natural redds (Tagart 1976).

In addition to directly affecting salmonid survival, fine sediment in deposits or in suspension can reduce primary production and invertebrate abundance (Hicks et al. 1991). These effects can reduce the availability of aquatic food sources important for fish (Cordone and Kelley 1960; Lloyd et al. 1987). In northern California, diversity of aquatic invertebrates was lower in streams passing through clearcut areas with no buffers or narrow buffers than it was in streams in unlogged watersheds. However, the densities of invertebrates in the clearcut areas was higher than those in unlogged watersheds (Newbold et al. 1980; Erman and Mahoney 1983). The detrimental effects of large amounts of fine sediment are generally accepted but precise thresholds of fine sediment concentrations that result in damage to benthic invertebrates are difficult to establish (Chapman and McLeod 1987; Wasserman et al. 1984).

Fine sediment in suspension can cause damage to juvenile salmonid gills and outright mortality when concentrations are excessively high (Noggle 1978). It was also found that low levels of suspended sediment were less damaging and to a certain degree beneficial as cover from predators (Noggle 1978).

Fine sediment that is transported over land can be filtered out by streamside buffer strips. The ability of streamside buffer strips to capture fine sediment is largely dependent on their width. Thus, buffer strip width is an important parameter for evaluating the ability of a management option to avoid excessive fine sediment delivery to streams. Recommended buffer widths for sediment removal vary widely (Johnson and Ryba 1992) and range from 3 meters (10 feet) for the coarse fraction to 122 meters (403 feet) for the fine fraction. Studies of forested watersheds recommend buffers of approximately 30 meters (100 feet) for this purpose (Johnson and Ryba 1992).

Wetlands are important sediment filters in many watersheds. Forested wetlands in particular have a high capacity to collect sediments (Hupp et al. 1993). Wetlands slow surface waters, allowing sediments to settle out of the water or adhere to vegetation. Oberts (1981) found that watersheds with less than 10 percent wetlands had sediment loading rates per unit area that were as much as 100 times greater than sediment loading rates of watersheds with more than 10 percent wetlands.

ALTERNATIVE A

Type 1 and 2 Waters would receive an average riparian management zone width which is well within the range of buffer widths for sediment filtering recommended in the literature. The riparian management zone widths on Type 4 and 5 Waters do not specify a minimum width and therefore do not always ensure that adequate sediment filtering would occur.

Under Alternative A, unstable slopes receive protection based on the Shaw and Johnson (in press) model. Because unstable slopes would often extend well beyond the riparian management zone in steep Type 4 and 5 Waters, the zones are likely too narrow to protect against upslope sediment sources. Only about half of Type 5 Waters would receive riparian management zones.

The lack of a comprehensive road management plan under Alternative A could further result in high road densities and consequent sediment runoff. Studies of existing logging roads in both the Clearwater (Cederholm and Reid 1987) and Hoh River (Schlichte et al. 1991) drainages on DNR-managed lands indicate that roads are a significant source of sediment that reaches streams.

The wetland buffers required in Alternative A will provide some protection to the sediment-catching function of wetlands. However, ground-based equipment within forested wetlands and wetland buffers could contribute to channelization and erosion of wetland soils, adding to sediment problems downstream.

ALTERNATIVE B

Riparian management zones on Type 1, 2, and 3 Waters would average in the middle to upper end of values recommended in the literature for protection from sediment runoff. A minimum riparian management zone width of 100 feet would be specified, so there would be no situations where no riparian management zones would be provided on these water types. An additional 100-foot-wide wind buffer would be provided along the Type 1 and 2 Waters and a 50-foot wind buffer would be provided along Type 3 Waters greater than 5 feet wide. This would further ensure that these riparian management zones were functioning to provide the sediment-filtering function. Type 4 Waters would receive 100-foot wide riparian management zones and Type 5 Waters in unstable slopes would receive protection based on the area of unstable area. Type 5 Waters in stable terrain would be protected by the Forest Resource Plan Policy No. 20.

The 25 feet of the riparian management zone closest to the stream would be a no-harvest area, and the area of the riparian management zone from 25-100 feet would be a minimal-harvest area; these zones would provide sufficient width to intercept sediments. Because the remaining portion of the riparian management zone (more than 100 feet from the active channel margin) would be a low-harvest area, then this zone should provide sufficient sediment filtering.

Under Alternative B, there would be a comprehensive landscape-based road management plan developed and instituted, which would have an objective of minimizing sediment runoff from roads reaching the streams. This would contribute to a road system with a low road density and high maintenance standard. Low road density and continuing road maintenance is expected to substantially reduce the risk of excessive sediment delivery to streams.

Hydrologic maturity of the forest is a major consideration under Alternative B and this would minimize adverse impacts of sedimentation and other channel destabilizations that can occur during rain-on-snow floods. Under Alternative A, consideration of hydrologically mature forest is not a specific requirement of timber sale layout, however, WAC 222-22-100 gives interim regulatory measures prior to watershed analysis in a WAU. Under this rule, DNR shall condition the size of clearcut harvests in the significant rain-on-snow zone where local evidence indicates that material damage to public resources has occurred during peak flows. Because this rule only affects harvests in watersheds where material damage to public resources has already occurred, some sedimentation and channel destabilization could occur.

Alternative B would protect against sedimentation of salmonid habitats better than Alternative A because of the wider riparian management zones and wind buffers on the headwater streams, the minimum riparian management zone width designation on Type 1 through 4 Waters, the allowance for hydrologic maturity in the rain-on-snow zone, and the comprehensive road management plan. Wetlands may help to keep sediments from entering streams if ground-based equipment is kept out of forested wetlands and wetland buffers. However, the use of ground-based equipment in and around wetlands is allowed under Alternative B.

ALTERNATIVE C

Riparian management zones for all Type 1 through 5 Waters would average one site potential tree height in width, which is at the upper end of the range of literature recommendations for protection from sediment runoff. A 100-foot wind buffer provided on both sides of the riparian management zone on Type 1 and 2 Waters and the 50-foot wind buffer on both sides of the larger Type 3 Waters will further minimize sedimentation of salmon streams.

There would be a 25-foot-wide area immediately adjacent to the stream that would be a no-harvest area. Stream bank stability would be the primary concern and a wider zone should be used where necessary to protect salmonid habitat from sedimentation.

The comprehensive, landscape-based road management plan will result in an improved situation for salmon habitat because it will result in fewer and better maintained roads. This should lower the probability of landslide failures and sediment runoff reaching salmon streams.

Under Alternative C, hydrologic maturity is a major consideration to minimize sedimentation of salmonid habitats and channel destabilization caused by rain-on-snow floods.

Alternative C provides more protection from sediment runoff than Alternative A, because of the wider and more consistent riparian management zones on all water types, limited harvest activity allowed in the riparian management zones, the wind buffers, allowance for hydrologic maturity in the rain-on-snow zone, and the comprehensive road management plan. Alternative C also provides good protection of wetlands through the use of buffers and the preclusion of ground-based equipment in forested wetlands and wetland buffers. These factors would allow wetlands to intercept sediment at natural or near natural rates.

Stream Bank Stability

Stream bank erosion is a natural process that occurs sporadically in forested and nonforested watersheds (Richards 1982; Thorne 1982). Under natural conditions, this process is part of the normal equilibrium of streams. The forces of erosion, resistance and sediment transport maintain natural conditions. Stream bank erosion can be accelerated by human activity. Important alterations that typically result from timber harvest activities include removal of trees from or near the stream bank, change in the hydrology of the watershed and increasing the sediment load which fills pools, and contributes to lateral scour by forcing erosive stream flow against the stream bank (Pfankuch 1975; Cederholm et al. 1978; Madej 1982; Roberts and Church 1986; Chamberlin et al. 1991).

Coarse sediment influx occurs primarily due to slope failures along Type 4 and 5 Waters, accelerated erosion of stream banks in larger streams, and failure of road prisms resulting in delivery of heavy loads of sediment to downstream channels. Consequently, the value of riparian management options for protecting stream bank stability is based on the widths of the respective buffer zones, activities allowed within the buffer zone, changes in watershed hydrology, and the potential for increased influx of sediment.

Peak flows may not be as important in affecting stream bank stability factors as buffer width and management activities allowed within the buffer. These factors affect root strength and sediment supply, the main variables affecting bank stability. Increased peak flows contribute incrementally more erosive power to streams. If stream banks are cut over, they will not have the resistive strengths to prevent erosion during peak flows (Hicks et al. 1991).

Channel morphology changes when timber harvesting increases the rate at which coarse sediment is delivered to streams (Hicks et al. 1991). Increased frequencies of landslides and other mass-wasting events can cause channels to aggrade where the gradient and other aspects of valley topography permit gravel deposition. Stream reaches that are aggraded with coarse sediments typically become wider, shallower, and more prone to lateral movement and bank erosion (Sullivan et al. 1987). Water passes through deposited gravels, reducing surface flow of summer rearing habitat (Cederholm and Reid

1987). Under these conditions the total riffle area may increase while pool area decreases and habitat may be lost (Everest et al. 1987).

Regional differences in the processes affecting stream bank stability are minimal to nonexistent with the exception of rain-on-snow and snow-dominated categories in the North Cascades. The physics of root strength, while not well understood in all situations, is not expected to vary significantly across western Washington. Therefore, response of stream banks to DNR timber management activities is expected to be similar across administrative regions.

ALTERNATIVE A

The width of the riparian management zones on Type 1, 2, and 3 Waters should be sufficient to protect stream bank stability, however, the lack of a minimum width of riparian management zones on the smaller streams would indicate that some Type 4 and 5 Waters would receive no protection. Most riparian management zones are currently treated as no-harvest areas, however, such treatment is not required under Alternative A and cannot be ensured in the future. Given these conditions, stream bank stability can be expected to be adversely impacted in at least some instances.

Roughly half of Type 5 Waters would receive riparian management zones averaging 40 feet in width (range 0-150 feet). The streams not receiving protection have potential to deliver sediment to downstream channels, which could further result in high rates of stream bank erosion and resulting stream bank instability in downstream areas.

The possibility of harvest activity within the riparian management zones under Alternative A leaves the possibility that some stream banks may be damaged. The lack of specifically applied wind buffers increases the risk that riparian management zones may blow down. Such blowdown would reduce stream bank stability in some areas, and perhaps result in direct and indirect stream bank damage.

Under Alternative A, consideration of hydrologically mature forest is not a specific requirement of timber sale layout, however, WAC 222-22-100 gives interim regulatory measures prior to watershed analysis in a WAU. Under this rule, DNR shall condition the size of clearcut harvests in the significant rain-on-snow zone where local evidence indicates that material damage to public resources has occurred during peak flows. Because this rule only affects harvests in watersheds where material damage to public resources has already occurred, some sedimentation and channel destabilization could occur.

There is no comprehensive road management plan under Alternative A and, therefore, stream bank erosion caused by high sediment runoff into channels may occur.

ALTERNATIVE B

Riparian management zone widths on Type 1 through 4 Waters under Alternative B are sufficiently wide to protect stream bank stability. Stream banks along Type 5 Waters in areas of unstable slopes would be protected. Type 5 Waters in stable areas, however, would be covered by Policy No. 20 of the Forest Resource Plan and this would not always ensure stream bank protection.

100-foot wind buffers would be applied to the windward side of Type 1 and 2 Waters and 50-foot wind buffers to the windward side of Type 3 Waters greater than 5 feet wide, in areas that are blowdown-prone. This would reduce stream bank damage caused by tree blowdown along the stream banks of these streams and further ensure that these streams would be protected from stream bank damage.

The 25 feet of the riparian management zone closest to the streams would be a no-harvest area, and this would lend considerable protection to stream bank stability.

Under Alternative B, hydrologic maturity is a major consideration to minimize adverse impacts caused during peak flow, such as during rain-on-snow floods. Because wider riparian management zones would be left on smaller headwater Type 4 and 5 Waters, increased peak flows are expected to diminish resulting in decreased annual erosion of stream banks. Decreased downstream delivery of sediment from Type 4 and 5 Waters would reduce the chance of stream bank erosion and lateral migration of the channel in downstream areas.

The comprehensive road management plan under Alternative B will further ensure that road densities and sediment runoff will be kept to a minimum.

Alternative B would provide more protection for stream bank stability than Alternative A, particularly on Type 3, 4, and 5 Waters, because it would provide wider riparian management zones and increased surety that management activities within these areas would not cause stream bank instability. Consideration of hydrologic maturity would reduce stream bank damage caused by peak flood events. The provision of additional 100-foot wind buffers in Alternative B on the windward side of Type 1 and 2 Waters and 50-foot wind buffers on the windward side of the larger Type 3 Waters would further increase the likelihood that the riparian management zones would protect stream bank stability.

ALTERNATIVE C

Riparian management zones of one site potential tree height in width would be provided on both sides of Type 1 through 5 Waters, and this should be sufficient to protect against direct damage to stream banks. Additional 100-foot wind buffers on both sides of Type 1 and 2 Waters and a 50-foot wind buffer on both sides of the larger Type 3 Waters would also ensure stream bank protection.

There would be a 25-foot-wide area immediately adjacent to the stream that would be a no-harvest area, and this would go a long way in ensuring stream bank stability. Stream bank stability would be the primary concern and a wider zone would be used where necessary.

Stream bank erosion would diminish because of the riparian management zones, which should decrease the annual delivery of sediment to downstream channels. Decreased downstream delivery of sediment from Type 4 and 5 Waters would reduce the chance of lateral migration of streams in downstream segments. Areas of instability along Type 4 and 5 Waters would be protected.

Under Alternative C, hydrologic maturity within the watersheds is a major consideration to minimize adverse impact to salmonid resources due to rain-on-snow floods.

Alternative C provides increased protection for stream bank stability compared to Alternative A by providing more consistent and wider riparian management zones on all water types, restriction of management activities in the riparian management zones that adversely impact stream bank stability, reduced peak flows in small headwater streams, and substantial windthrow buffering.

Stream flow

Timber harvest can alter drainage-basin hydrology through its effects on a number of forest stand properties including transpiration, interception, evaporation of rainfall, fog, snow, soil structure, and resultant water infiltration and transmission rates (Chamberlin et al. 1991). Increases in the length of the drainage network through added road mileage can also significantly influence stream flow (Grant 1994). Though changes in stream flow are expected from timber harvest activities, the direction and magnitude of these changes vary and specific effects cannot be easily predicted.

Timber harvest can influence stream flow by altering the amount of snow accumulation and the rate of the associated melt. In general, loss of vegetation from timber harvest decreases the snow-interception and evapotranspiration properties of the forest, thereby increasing water yields (Bosch and Hewlett 1982). An intact coniferous forest canopy normally captures snow which then evaporates or melts rather than accumulating on the ground. However, in clearcut and thinned stands, the forest floor accumulates considerable quantities of snow due to the decrease in the snow-interception properties of the forest canopy. Snow accumulated in canopy openings also melts more rapidly than snow in the surrounding forest due to direct exposure to atmospheric heat. Resultant increased water yields can be expressed in either increased summer base flows or increased peak flows (Bosch and Hewlett 1982). Increased peak flows are generally more detectable in streams at lower discharges as compared to higher discharges (Rothacher 1973; Lyons and Beschta 1983). Similarly, such changes in peak flow are more detectable in smaller rather than in larger drainage basins.

The elevational range over which snow might accumulate and melt, perhaps several times in one season, is called the rain-on-snow zone. In western Washington, this zone occurs between approximately 1,200 and 4,000 feet (366 to 1220 meters) above sea level (WFPB 1995b). Melting of snowpacks accumulated in harvested areas can be further accelerated during rainstorm events, resulting in even higher rates of water input to soil and streams than would occur otherwise (Harr 1986; Berris and Harr 1987; Harr et al. 1989). These peak flows are known as rain-on-snow events. Hydrologic maturity refers to the percentage of a watershed that is comprised of forest with a predominantly closed canopy within the rain-on-snow zone. A forest is said to be hydrologically mature when it has the structure and composition that causes it to behave hydrologically in a manner similar to mature forest. Hydrologic maturity is important because of its effects on the amount of snow accumulation and associated rain-on-snow events. The greater the canopy openings and the younger the stands within an area, the greater the potential snow accumulation, and thus the greater the available water to contribute to peak flows during a rain-on-snow event.

Significant recovery from hydrologic changes in a forest tends to be gradual. Grant (1994) observed little recovery after 30 years. Harr reported 50 percent recovery was achieved in 25 years (Harr et al. 1989). The effects of an extended drainage network via roads will last as long as the road system is maintained. The potential for increased snow accumulation continues within a harvested stand until the second-growth canopy closes. The age at which closure occurs depends on site quality, species composition, and the number of trees left after harvest, but occurs at an age of approximately 25-35 years for clearcuts in western Washington (WFPB 1995b).

The percentage of a watershed harvested is generally correlated positively with stream flow. Several studies have shown that harvest of at least 25-40 percent of basin area is required within a period of 5-15 years before effects on mainstem flow are detectable (Rothacher 1970, 1973; Harr et al. 1979; Duncan 1986). Rothacher (1970) investigated a 237-acre (96-hectare) watershed in Oregon that was 100 percent clearcut and was able to detect stream flow increases after about 40 percent of the basin had been harvested. In another study (Hetherington 1987), a 90 percent clearcut harvest in 1 year on a 2,964-acre (1,200 hectare) tributary on Vancouver Island resulted in a 14 percent increase in annual water yield, a 78 percent increase in summer low flow, and a 20 percent increase in peak flows. Some ongoing investigations also document increases in peak flows in mainstem channels due to timber harvest (Grant 1994).

In contrast, Hicks et al. (1991) presented long-term data from the same 237-acre (96 hectare) watershed investigated by Rothacher (1970, 1973) and documented decreases in summer low flow. They found that water yield increased above that of the control watershed for approximately 8 years. However, for the next 19 years of record late summer water yield decreased below that of the control watershed. This decrease in flow may have been related to increased transpiration by second-growth alder. Harr (1982) has shown that logging may also decrease summer low flows by reducing fog-drip in fog-influenced forests.

In forested environments, most water is delivered to streams by subsurface flow through the soil. Logging operations that compact soil may increase surface runoff which could either increase or decrease peak flows. Generally, overland flow is faster than subsurface flow, thus increases in peak flow may occur through inhibition of subsurface flow due to soil compaction (Jones 1987). Cheng (1988) indicated the opposite effect in southern British Columbia. In that case, logging had compacted the soil, delayed water infiltration, slowed water transmission through soil macropores and reduced peak flows.

Roads constructed in conjunction with timber harvest can also gather and transmit water faster than the natural landscape, thereby altering basin hydrology (Harr et al. 1975; Harr 1979). Roads, and their associated ditches, can intercept both surface and subsurface flow and redirect this water toward stream channels, potentially changing the timing and magnitude of peak flows. Poorly designed roadside ditches can essentially become extensions of the stream system (Wemple 1994). In one study, roads caused the winter stream drainage density to increase 38 percent over the pre-road conditions (Grant 1994).

A sub-basin in western Washington which is completely within the significant rain-on-snow zone is estimated to yield an additional inch of water during a 10-year 24-hour rain-on-snow event if one-third of the sub-basin is in a hydrologically immature condition. The implicit assumption used to develop WAC 222-16-046 is that peak flows caused by the addition of 1 inch of water onto a 10-year 24-hour storm, a storm of moderate intensity, present an acceptable level of risk to public resources.

The appropriate size of the drainage basin for the hydrologically-mature forest prescription was based on guidelines in the hydrology module of watershed analysis (WFPB 1995b) and their current application by hydrologic analysis. In watershed analysis, increases of peak flow greater than 10 percent are considered to offer the possibility of adverse effects to public resources. It is generally recognized that the precision of flow measurements is on the order of 10 cubic feet per second. Therefore, 100 cubic feet per second (a 10 percent change of 100 cubic feet per second equals 10 cubic feet per second) seems to be a reasonable level of peak flow from which to derive the appropriate drainage basin size.

Bankfull channel discharge is a geomorphologically effective discharge that causes long-term channel erosion and sediment transport (especially bedload movement). A regression equation relating bankfull discharge to drainage basin area for the Puget Lowland and western Cascades (Frederick and Pitlick 1975; Parsons 1976; Dunne and Leopold 1978
p. 616-617) shows that approximately 100 cubic feet per second of bankfull flow can be generated by a drainage basin having an area of approximately 1220 acres.

In addition, a review of watershed analysis reports shows that most hydrologic analysis units (HAUs) are greater than 900 acres. In a few instances, HAUs are as small as 350 acres, but these are fragmented areas between basins of significant creeks. Most hydrologic analysts involved in watershed analysis delineate HAUs that are 1,000 acres or more.

In some 100-acre drainage basins there will be little risk of material damage to salmonid habitat during rain-on-snow floods. For instance, in basins with less than one-third of their area in the significant rain-on-snow zone, the estimated additional yield due to rain-on-snow during a 10-year 24-hour storm is less than 1 inch. In basins with at least two-thirds of their area in the significant rain-on-snow zone, covered by hydrologically-mature forests and reasonable assurance that it will remain in that condition (e.g., forests in national parks or national forest Late-Successional Reserves), there is little risk of material damage to salmonid habitat. In some basins, due to ownership patterns, DNR management will not significantly decrease the risk of material damage. Consider a basin with exactly half of its area in the significant rain-on-snow zone under DNR management. If other owners did not manage for hydrologically-mature forest and DNR maintained two-thirds of its forest lands in a hydrologically mature condition, only one-third of the area in the significant rain-on-snow zone would be hydrologically-mature forest. During a 10-year 24-hour rain-on-snow event, the estimated additional yield of water due to a hydrologically immature area is 2 inches. DNR management, in this case, would not significantly decrease the risk of material damage because a 2-inch additional yield is expected to cause material damage to salmonid habitat.

Wetlands can augment stream flows during low-flow periods through their storage of water and subsequent discharge to subsurface flow or direct input to streams. Wetlands can also be quite important in attenuating flood peaks during storm events by absorbing storm water and releasing it slowly (Richardson 1994). Flood peaks have been linked with declines in coho smolt yield during the most extreme discharges (Seiler 1994; Cederholm et al. in prep.).

ALTERNATIVE A

Under the existing Forest Resource Plan (DNR 1992b), the mechanism by which hydrologic maturity is to be addressed is watershed analysis (WFPB 1995b). At this time, not all watersheds have had an analysis, and the analysis of all watersheds may require decades to be completed. Where watershed analysis is complete, the hydrology module is designed specifically to address and minimize increases in peak flows during rain-on-snow events by evaluating all Type 3 Water sub-basins individually. Under Alternative A, consideration of hydrologically mature forest is not a specific requirement of timber sale layout, however, WAC 222-22-100 gives interim regulatory measures prior to watershed analysis in a WAU. Under this rule, DNR shall condition the size of clearcut harvests in the significant rain-on-snow zone where local evidence indicates that material damage to public resources has occurred during peak flows. Because this rule only affects harvests in watersheds where material damage to public resources has already occurred, some sedimentation and channel destabilization could occur. The contribution of roads to peak flows and decreases in summer low flow caused by timber removal are not presently addressed in the watershed analysis.

The hydrology module assumes that peak flows that are 10 percent higher than background conditions may have significant adverse effects. This threshold was selected based on the resolution of stream-gauge data, which is generally plus or minus 10 percent. The methodology presented to evaluate the percentage of peak flow change uses a variety of regional discharge estimates and available stream-gauge data. Whether this methodology provides sufficient resolution to determine a realistic 10 percent flow change or whether the 10 percent threshold adequately protects against significant rain-on-snow events is uncertain.

Wetlands would be protected to ensure no net loss of acreage or function.

ALTERNATIVE B

Alternative B would minimize the amount of hydrologic change within a basin by requiring that rain-on-snow considerations be applied, thus increasing the amount of forest cover. Two-thirds of the rain-on-snow and snow-dominated zones on DNR-managed land within each Type 3 sub-basin would be maintained in a hydrologically mature state. With much of the area maintained in a hydrologically mature state, increases in peak flow due to timber harvest are expected to be minimal. Additionally, the Shaw and Johnson (in press) slope stability model would be applied to identify areas of slope instability.

There are substantial riparian management zones left along Type 1 through 4 Waters and protection of Type 5 Waters in areas of unstable slopes, which contributes to additional hydrologically-mature forest within a drainage basin. There is a 100-foot-wide wind buffer left on the windward side of blowdown-prone Type 1 and 2 Waters, and a 50-foot buffer left on larger Type 3 Waters that are in similarly blowdown-prone areas.

The 25 feet of the riparian management zone closest to the stream would be a no-harvest area, and a wider zone would be established where necessary. It is anticipated that only ecosystem restoration would occur in this area. Activities occurring between 25 and 100 feet from the active channel must not appreciably increase stream flow. It is anticipated that only two types of silvicultural activities will occur in this area: ecosystem restoration and single-tree selective harvest. The remaining portion of the riparian management zone (more than 100 feet from the active channel margin) will be a low-harvest area. It is anticipated that single-tree selective harvest thinning operations, salvage operations, and partial harvest will occur in this area.

The comprehensive road management plan under Alternative B will minimize active road density and thus reduce the negative effects of high road density on peak flows.

Alternative B would provide similar wetlands protection compared with Alternative A.

Alternative B provides more protection than Alternative A for hydrologic impacts on stream flow with greater protection of Type 3 sub-basins within the rain-on-snow zone, wider riparian management zones on Type 4 Waters, wind buffers, a comprehensive road management plan, and the provision of additional leave areas along Type 5 Waters in unstable slopes.

Alternative C

Alternative C provides significant protection of salmonid habitats by ensuring that two-thirds of DNR-managed lands within the significant rain-on-snow zone in Type 3 sub-basins be maintained in a hydrologically mature condition.

Riparian management zones equal in width to one site potential tree height would be provided on all water types. There would be an additional 100-foot wind buffer on both sides of Type 1 and 2 Waters and a 50-foot wind buffer on both sides of the larger Type 3 Waters. The addition of wind buffers on both sides of streams reduces the amount of timber harvested at any given time, thereby slightly reducing hydrologic changes. This would minimize hydrologic changes to streams that are direct tributaries to Type 3 basins.

A 25-foot-wide area immediately adjacent to the stream would be a no-harvest area. From there to the outer edge of the protected area, activities would be allowed only if the activity serves to restore and/or enhance the function of the riparian ecosystem and/or the buffer. However, even after the stands reach a mature state, the only activities allowed would be those restoring/enhancing ecosystem or riparian management zone function.

Alternative C would benefit stream flow moderation and augmentation more than Alternative A through a more protective wetland strategy. Restriction of ground-based equipment within the wetland and wetland management zone (WMZ) would prevent channelization of the wetland and help to maintain wetland hydrologic function.

The comprehensive road management plan under Alternative C will help minimize active road density and its negative effects on hydrology.

Alternative C is more protective than Alternative A because of the protection of the rain-on-snow dominated zone, the maintenance of hydrologic maturity, comprehensive road management plan, the provision of wide riparian management zones on all water types, and the provision of wind buffers on both sides of the larger streams.

Wetlands

Although the evaluation of alternatives in relation to the preceding components focused on salmonid habitat, a broader perspective is applied to evaluating the alternatives in relation to wetlands. This evaluation addresses hydrology (low-flow augmentation and flood-peak attenuation), stream flow and salmon habitat, water quality, wildlife, and wetland vegetation.

Wetlands have tremendous value in forested watersheds for several reasons. An important component in forest hydrology, wetlands help to moderate the stream flow and regulate water quality, directly influencing riparian habitats downstream. Unique habitats in themselves, wetlands provide forage, shelter, breeding and resting areas for many wildlife species, and habitat for unique and sometimes rare plant species. The wetland alternatives presented in the HCP are designed with the primary intention of maintaining wetland hydrologic function for the benefit of downstream salmon habitat. Wetland hydrology and wetland habitats are of importance to a broad range of other species as well, throughout the riparian ecosystem.

The following is a brief discussion of the various functions that wetlands serve. It should be recognized that wetland functions can vary considerably by wetland type, and thus the functions outlined below may not necessarily be performed in every wetland. Also, Brinson (1993) states that the "...less frequently flooded portions of wetlands are no less functionally active than wetter portions; the functions are simply different." It is important to be cautious about value judgements placed on any particular wetland.

Wetlands - Hydrology: Low-flow augmentation, flood-peak attenuation. Our understanding of wetland hydrology specific to the Pacific Northwest is rudimentary. However, based on what we do know, a cautious approach to wetlands management is warranted. Because most studies have been done in the southeastern or lake states, extrapolation of any conclusions needs to be done carefully.

Wetlands are a primary part of the permanent soil and ground water hydrology of forests on many watersheds. Their influence on stream hydrology has been repeatedly demonstrated (Winter 1988; Waddington et. al. 1993). Specifically, wetlands can augment stream flow during low flow periods through discharge of ground water, storage of water and subsequent discharge through soil interflow, or direct contribution to streams.

Wetlands also play an important role in moderating flows during storm events, dampening stormflow and storing the water for future discharge (Richardson 1994). Empirically derived equations predicting stream flow (Jacques and Lorenz 1988) show that storm floodflows are proportional to the negative exponent of the proportion of the watershed area that is in wetlands and lakes. That is to say, wetlands in watersheds with few wetlands have a disproportionately large impact on reducing floodflows. The equations predict that a watershed containing as little as 5 percent wetlands would have a storm floodflow that is 50 percent lower than if there were no wetlands. Johnston et al. (1990) applied the same equation and found that a watershed with 1.6 percent lakes and wetlands had a flow-per-unit watershed area that was 10 times greater than the flow predicted for a watershed where 10 percent of the area was lakes or wetlands. The conclusions of these studies strongly suggest that the loss of any wetlands in watersheds where there is less than 10 percent wetlands would be significant.

ALTERNATIVES A AND B

Alternatives A and B are designed to help maintain the natural hydrology of wetlands through protecting wetland soils from compaction and channelization, and maintaining wetland vegetation to the extent that it can continue near-natural rates of evapotranspiration.

This is accomplished through maintaining managed buffers around both forested and nonforested wetlands, and imposing restrictions on the amount of timber volume that can be removed. These restrictions should in most cases protect the wetland's ability to store, release and exchange surface and ground water at natural or near-natural capacity, and to recover from management activities without impairing hydrologic function significantly.

ALTERNATIVE C

Alternative C provides more protection to wetland hydrologic function by buffering small wetlands that function together as a larger wetland, by increased protection of the wetland edge (which will in turn provide more protection to wetland inflows and outflows, hopefully preventing channelization and conversion of subsurface flow to surface flow), and by ensuring that the trees left in buffers and forested wetlands are the most windfirm trees available, to avoid losses by blowdown.

Wetlands - Stream flow and salmon habitat. Low summer flows have been regarded as a primary determinant of natural coho production in western Washington since the mid-1950s when Smoker (1955) reported on a significant relationship between salmon catch and stream flow during the year those fish were reared. Seiler (1995) found a correlation between summer low flows and poor coho smolt survival. The working hypothesis is that summer low flows limit the amount of habitat during summer rearing, thereby setting the stream's capacity for a given brood.

Summer stream flows have direct influence on habitat size, have often been assumed to be the limiting factor to smolt yield, and have been used in forecasting adult natural coho run sizes for Puget Sound (Zillges 1977). Lestelle et al. (1993) recently found coho smolt yield to be correlated with summer stream flows of the previous year in five of thirteen streams analyzed in western Washington.

The potential effects of stream flow on coho production are not limited to summer flows. Benefits that fall and winter high stream flows provide are likely negated by streambed scour and mortality to incubating eggs. Seiler (1995) found a significant negative correlation between winter flow during the incubation period and smolt yield 2 years later. Storm flow can also impact salmon populations by catalyzing debris flows and slope failures into streams, directly killing salmon eggs (Seiler 1995).

Variable stream flow can also affect salmon survival. High flows can reduce fry survival during dispersal following emergence (Holtby 1988). During fall high flow periods, juvenile coho salmon have been found to seek refuge in small spring and pond feed tributaries of the Clearwater River (Peterson 1982b; Cederholm and Scarlett 1982).

ALTERNATIVES A AND B

Soil disturbance and over-cutting in wetlands and their buffers are the main threats to the wetland functions that moderate stream flows and benefit salmon habitat. If fully implemented, Alternatives A and B should provide some protection to wetland recharge and discharge areas through buffers, particularly if ground-based equipment is used judiciously in the buffer and kept out of the wetland entirely. Such restrictions on equipment are not mandatory under these alternatives, however. The maintenance of the required basal area will also help to keep the wetland hydrology within natural parameters. However, if the basal area that is left does not contain large windfirm trees, the evapotranspiration rates could be lower, the water table could rise and the risk of loss through blowdown would increase.

ALTERNATIVE C

Several factors make Alternative C substantially more protective than Alternatives A and B. First, the restrictions on ground-based equipment in forested wetlands and within 50 feet of the wetland's edge will improve chances that wetland inflow and outflow will retain their natural character. The mandatory selection of large dominant and co-dominant windfirm leave trees will help to maintain the integrity of the buffer and near natural evapotranspiration rates, both of which should help the wetland moderate stream flows. The buffering of small, interconnected wetlands could have a sizable impact on both flood-peak attenuation and low flow stream augmentation in some watersheds. Finally, the added protection of small bogs may contribute to stream flow moderation. Bogs are hydrologically isolated "donor" wetlands that receive water almost exclusively through precipitation, and for this reason do not have inflows. They do have outflows however, and may be important in some watersheds for low flow stream augmentation.

Wetlands - Water quality. Wetlands can play a critical role in maintaining water quality. Wetlands slow surface water flow, allowing water-borne sediments to precipitate or adhere to vegetation. Oberts (1981) found that watersheds with less than 10 percent wetlands had sediment loading rates per unit area that were as much as 100 times greater than suspended solid loading rates of watersheds with more than 10 percent wetlands. Forested wetlands in particular appear to have a disproportionately high capacity for sediment trapping (Hupp et al. 1993). This sediment trapping function can be of great benefit to salmon habitat downstream. Cederholm and Reid (1987) found that salmon survival to emergence was reduced 50 percent as a consequence of increased sedimentation in two heavily roaded sub-basins of the Clearwater River.

Wetlands can also positively influence water temperature in streams during warm summer months by contributing cool ground water or surface and subsurface flow that has been shaded.

As water temperature and sedimentation are the two most limiting factors to water quality in most forested watersheds, these wetland functions are particularly important. In addition to sediment trapping, wetlands have the capacity to remove various pollutants from water, because such pollutants tend to bond to suspended sediments and become entrapped in wetland soils and vegetation.

Prior to the Forest Resource Plan (DNR 1992b), DNR did not have explicit direction to fully protect wetlands. Consequently, past forest practices on DNR-managed land often resulted in the loss of wetlands or a degradation of wetland function. Forest Resource Plan Policy No. 21 directed "DNR to allow no overall net loss of wetland acreage and function." This policy has yet to be completely implemented, and so some loss of wetland acreage or function may have occurred since the formal adoption of the Forest Resource Plan. The No Action alternative represents the forest management prescriptions that are thought to be the most effective implementation of Policy No. 21.

ALTERNATIVES A AND B

As with other aspects of wetland hydrology, the primary threats to water quality in wetlands and the water that they contribute to downstream systems are from soil and vegetation disturbance. If fully implemented, the buffers required for Alternatives A and B will act to prevent erosion and maintain the wetland's ability to filter sediments and pollutants. The maintenance of some trees and other wetland vegetation in forested wetlands and buffers should help keep water temperatures cool. This could be of benefit to salmon habitat downstream during warm, low flow periods.

ALTERNATIVE C

Protection of water quality under Alternative C may be increased due to more restrictive cutting requirements, better protection of wetland soils due to restrictions on ground-based equipment, and increased protection of small, interconnected wetlands and bogs. The benefits of these measures are similar to those described for Alternatives A and B.

Wetlands - Wildlife. Wetlands receive a disproportionately high amount of use by wildlife compared to upland areas. It has been estimated that of 414 wildlife species in western Washington and Oregon, 359 rely on the use of wetland or riparian areas for some seasons or some part of their lives (Brown 1985). Some species such as beavers and some species of amphibians are completely dependent on wetlands for their entire life cycle, while others such as raccoons and myotis bats may use wetlands for only part of their needs.

Wetlands have very high levels of net primary productivity, and also provide rearing habitat for many insect species that are a very important part of many food webs. For this reason, many wildlife species such as raptors and coyotes are indirectly supported by wetland environments because their prey base comes from wetlands. Because wetlands tend to support higher concentrations of prey species than surrounding uplands, they can improve the habitat quality of adjacent uplands by proximity.

Prior to the Forest Resource Plan (DNR 1992b), DNR did not have explicit direction to fully protect wetlands. Consequently, past forest practices on DNR-managed land often resulted in the loss of wetlands or a degradation of wetland function. Forest Resource Plan Policy No. 21 directed "DNR to allow no overall net loss of wetland acreage and function." This policy has yet to be completely implemented, and so some loss of wetland acreage or function may have occurred since the formal adoption of the Forest Resource Plan. The No Action alternative represents the forest management prescriptions that are thought to be the most effective implementation of Policy No. 21.

ALTERNATIVES A AND B

The partially forested buffer areas left around wetlands under these alternatives would provide some habitat features important to a wide variety of wildlife species. Trees left in forested wetlands and buffer areas should provide roosting, nesting, foraging, and shelter areas. Over time, snags might be available for nesting and foraging sites. The benefits of these buffers would be reduced for some species if blowdown due to rising water levels or non-windfirm trees were to reduce stand density in the buffer. Other species might benefit from increased edge habitat. The hydrology and water quality protection offered by these alternatives would benefit any aquatic species, both within and downstream of the wetland.

ALTERNATIVE C

The potentially more stable buffer areas and undisturbed portions of nonforested wetland buffers should increase wildlife habitat values over those provided by Alternatives A and B. Protection of small bogs would benefit some bog-dependent species. Perhaps one of the most important differences between Alternative C and Alternatives A and B is the protection offered to small interconnected wetlands. Small wetlands are believed to be very important in supporting wetland-associated taxa. Gibbs (1993) found through modeling the disturbance of the smallest wetlands (0.1-4.5 hectares) (0.25-11 acres) on a landscape, that small wetlands play a disproportionately large role in the maintenance of associated animals. Using a spatially-structured demographic model, Gibbs found that stable populations of turtles, small birds and small mammals faced a significant risk of extinction after loss of the smallest wetlands representing 14 percent of the total wetland area on the watershed.

Wetland vegetation

Wetlands provide habitat for many plant species that are otherwise rare in the forest. Some of these species are highly specialized for specific hydrologic and nutrient regimes, while others have broader ecological amplitudes (can survive a broader range of environmental conditions). Due to historic losses of wetland habitats, many federally and state-listed rare plant species are wetland-dependent species.

ALTERNATIVES A AND B

Protection for rare plants under Alternatives A and B is provided chiefly through buffers and provisions that support natural wetland hydrology. If ground-based equipment were to be kept out of wetland buffers, wetland plants would benefit from less soil disturbance. Also, the seeds of invasive exotic species can often be brought into wetland areas by heavy machinery, which also prepares a suitable seed bed. These species can sometimes outcompete native species and constitute a threat to some of the federally and state-listed wetland species.

ALTERNATIVE C

More restrictive harvest and ground-based equipment requirements through Alternative C would benefit wetland vegetation by reducing disturbance and improving the protection to wetland hydrologic functions. In addition, added protection for small bogs and interconnected wetlands will increase the amount of protected habitat substantially in some watersheds.

4.3.1 Northern Spotted Owl

Summary

Our analysis shows that Alternative C is expected to best enhance the survival and recovery of spotted owls in the Eastern Washington Cascades Province (see Matrix 4.3.1). For all six evaluation criteria, Alternative C results in either the greatest net benefit or the least adverse impact to the owl population. Alternative C provides the largest amount of NRF and dispersal habitat (Table 4.3.23). Owl habitat will be the least fragmented, have the widest geographic distribution, and be maintained with a high level of certainty. Also, under Alternative C the fewest site centers suffer adverse impacts.

The comparison of Alternatives A and B can be reduced to an assessment of short-term risk versus long-term risk. Alternative B poses greater short-term risk to the spotted owl population in the Eastern Washington Cascades Province, but Alternative A poses greater long-term risk. Over the short term, Alternative B harvests more owl habitat and puts more site centers at risk for take (Table 4.3.23). Alternative A is likely to maintain a larger proportion of existing owl habitat and site centers over the short term, but over the long term, natural disturbance and shifting site centers are likely to cause a substantial reduction in both habitat and occupied site centers. An important element in comparing the long-term risk of the alternatives is certainty. Alternative B is projected to remove more habitat, but the amount and spatial distribution of the remaining habitat, and habitat to be developed, are known and the product of a conservation plan. It is likely that under Alternative A, owl habitat on DNR-managed lands will become more fragmented and less capable of supporting spotted owls. Furthermore, under Alternative A, low confidence must be assigned to any estimate of future owl habitat conditions on DNR-managed lands. This is particularly true in the eastern Washington Cascades where fire suppression has greatly increased the probability of catastrophic disturbance.

Our assessment leads to us to conclude that the long-term risk of extinction is less under Alternative B. Is this long-term benefit worth the short-term risk? In other words, will the short-term risks appreciably reduce the likelihood of survival and recovery of the species? The President's Forest Plan included an assessment of the likelihood that the plan would support species' populations (FEMAT 1993). Panelists assessing the spotted owl population assigned an 83 percent likelihood to outcome A (FEMAT 1993 p. IV-153) -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, well-distributed across federal lands. The remaining 18 percent was assigned to outcome B -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, but with significant gaps in the historic species distribution on federal land. In effect, the panelists concluded that the risk of spotted owl extinction under the President's Forest Plan is zero. In an independent assessment, USFWS stated that the President's Forest Plan "...should provide a strong habitat network to maintain a viable and self-sustaining population of spotted owls for the next 100 years." (USDA and USDI 1994a p. G-18). If the President's Forest Plan is successfully implemented, then the short-term risk to the species is minimal. Placed in this context, the long-term benefits of Alternative B are worth the short-term risk.

Alternative B follows the principles propounded by the Northern Spotted Owl Recovery Team. They stated, "Emphasis should be placed on management for clusters, or local population centers, of owls in large habitat blocks rather than for individual pairs" (USDI 1992b p. 57). Alternative B concentrates owl habitat in proximity to federal reserves, and is thus more likely to support spotted owls clusters on federal reserves. Again, under Alternative A, owl habitat on DNR-managed lands is expected to become more fragmented, i.e., less concentrated, and the spatial arrangement of habitat will be astrategic. In short, Alternative B provides better conservation for spotted owls in the eastern Washington Cascades than Alternative A.

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Spotted Owl			
Nesting, Roosting, and Foraging (NRF) habitat	Within spotted owl site centers (1.8- or 2.7-mile radius), 40% of total acreage is maintained in suitable owl habitat. The remaining area will be harvested. No additional acreage will become habitat.	202,000 acres designated for NRF function in N. Puget, S. Puget, Columbia, Chelan, Yakima, and Klickitat planning units with at least 101,000 acres (50%) developed and maintained at any time. On the west side, two 300-acre nest patches[1] per 5,000 acres (approximate) of NRF are identified and retained until knowledge is acquired allowing provision of adequate nesting structure while managing entire acreage. Balance of acreage may be sub-mature forests.	337,000 acres designated for NRF function in Straits, N. Puget, S. Puget, Columbia, Chelan, Yakima, and Klickitat planning units with 202,000 acres (60%) developed and maintained in a late-seral forest condition at any time.
Dispersal Habitat	No provision for dispersal habitat.	200,000 acres designated for dispersal function in Yakima, N. Puget, S. Puget, Klickitat, and Columbia planning units with at least 100,000 acres developed and maintained at any time.	172,000 acres designated for dispersal function in Yakima, N. Puget, S. Puget, Klickitat, and Columbia planning units with 86,000 acres developed and maintained at any time.
Experimental Areas	No provision for experimental areas.	No provision for experimental areas.	43,000 acres designated for experimental management in S. Coast Planning Unit.

[1] See draft HCP for details of the nature and configuration of these areas for various planning units.

Regional Context

The three eastern Washington HCP planning units all lie within the Eastern Washington Cascades Province (USDI 1992b). The wide range of environmental conditions in the eastern Cascades supports a variety of climax forest types. The ponderosa pine, Douglas-fir, western hemlock, grand fir, and subalpine fir forest zones are all present in the Eastern Washington Cascades Province (Franklin and Dyrness 1973). In general, mixed conifer forests and ponderosa pine forests predominate at low to mid-elevations and true firs predominate at high elevations (FEMAT 1993). Historically, wildfire has played a central role in the landscape dynamics of the eastern Washington Cascades. This is particularly true for ponderosa pine forests which are fire-maintained subclimax communities. Forest fire suppression during the past 60-80 years has altered the natural patterns of community succession (Franklin and Dyrness 1973; FEMAT 1993) and made forests more susceptible to catastrophic fires, insect attacks, and disease (FEMAT 1993). Consequently, any habitat conservation plan in the eastern Washington Cascades should attend to fire management and forest health issues.

Threats. The Northern Spotted Owl Recovery Team (USDI 1992b) described the major known threats to spotted owl populations in each province. In the eastern Washington Cascades, the most severe threats to the continued existence of spotted owls were thought to be habitat distribution and natural disturbance. Most spotted owl habitat in the province is clustered in a few key areas: the Yakama Indian Reservation, and the Naches, Cle Elum, Leavenworth, and Lake Wenatchee ranger districts of the Wenatchee National Forest. Fire suppression in these same areas has greatly increased the probability of large-scale stand-replacement fires (USDI 1992b), which could destroy one or more of these key areas and increase the risk of extinction. Over the entire range of the northern spotted owl, the risk of catastrophic natural disturbance was rated highest in the east Cascades subregion (i.e., the eastern Cascades of Oregon and Washington).

The recovery team concluded that active management was necessary to reduce the risk of catastrophic natural disturbance (USDI 1992b p. 183-184). Their recommended management strategies would protect owl habitat by degrading owl habitat. For example, to reduce risks from fire a fuel break system and controlled underburning were recommended. Also, thinning of stands was recommended to reduce risks due to insect infestations.

Declining habitat, limited habitat, small populations, and isolation were thought to be moderate threats to the continued existence of spotted owls in the Eastern Washington Cascades Province. Like all other provinces in the range of the spotted owl, low-elevation mature and old-growth forest in the eastern Washington Cascades has been subject to high rates of harvest. While the amount of spotted owl habitat has declined, partial harvest techniques, which are common in the eastern Cascades, may contribute to maintaining habitat (USDI 1992b).

Habitat and Reserves Provided on Federal Lands. Sixty percent, or 3.47 million acres, of the Eastern Washington Cascades Province is under federal ownership (USDA and USDI 1994a). Approximately 20 percent of federal lands are currently suitable spotted owl habitat (USDA and USDI 1994a p. 3&4-222). Congressionally Reserved Areas which constitute 43 percent of federal ownership in the eastern Washington Cascades (USDA and USDI 1994a p. 2-39) contain 30 percent of federally-owned suitable spotted owl habitat (USDA and USDI 1994a p. 3&4-222). The President's Forest Plan establishes 23 Late-Successional Reserves in the Eastern Washington Cascades Province. These LSRs encompass 876,773 acres of which 290,556 acres are currently spotted owl habitat -- 38 percent of federally-owned habitat in the eastern Washington Cascades (USDA and USDI 1994a p. G-13). Managed LSRs and Riparian Reserves of the President's Forest Plan and Administratively Withdrawn Areas contain an additional 16 percent of federal spotted owl habitat. In total, 84 percent of current spotted owl habitat on federal lands are protected or will be protected under the President's Forest Plan.

Over the next 100 years, a large amount of spotted owl habitat is expected to develop on federal lands in the Pacific Northwest. Currently, 32 percent of all Congressionally Reserved Areas, Administratively Withdrawn Areas, and Late-Successional Reserves in the range of the northern spotted owl are suitable spotted owl habitat (USDA and USDI 1994a p. 3&4-222). Under the President's Forest Plan, on average about 80 percent of these reserves would be covered by late-successional forest (USDA and USDI 1994a p. 3&4-42). No habitat projections have been made for individual provinces, but applying this average to federal reserves in the eastern Washington Cascades suggests that spotted owl habitat may increase from 712,000 acres to 2.1 million acres.

Current Conditions on DNR-Managed Lands

This section presents a summary description of conditions on and near DNR-managed lands. The information presented is used in the evaluation of alternatives and establishes a context in which to assess their impacts.

Number and Distribution of Spotted Owls. The median home range radius of spotted owls in the eastern Washington Cascades is approximately 1.8 miles. This radius is used to delineate "owl circles," which are used by USFWS to assess the incidental take of spotted owls. In the east-side planning units, there are 78 spotted owl circles (status 1, 2, and 3) that contain DNR-managed lands. Eighteen of these circles have their site centers situated on DNR-managed lands. There is no appreciable difference among planning units in the number of owl circles that contain DNR-managed lands (Table 4.3.1). As of May 1995, there were 291 status 1, 2, or 3 spotted owl site centers in the eastern Washington Cascades. Therefore, DNR management activities have the potential to affect 27 percent of the known site centers in this province.

Table 4.3.1: Spotted owl site centers (status 1, 2, and 3) within a median home range radius of DNR-managed lands by planning unit

The median home range radius is used to delineate "owl circles." In the eastern Washington Cascades the median home range radius is 1.8 miles.

HCP Planning Unit	Number of territorial pair and single owl site centers	% territorial pair and single owl site centers
Chelan	20	26
Yakima	30	38
Klickitat	28	36
total	78	100

Table 4.3.2: Spatial distribution relative to federal reserves of spotted owl site centers (status 1, 2, and 3) within a median home range radius of DNR-managed lands

The median home range radius is used to delineate "owl circles." In the eastern Washington Cascades the median home range radius is 1.8 miles. The first distance band, -2.0 - 0.0 miles, contains site centers on federal reserves.

Distance from federal reserves (miles)	Number of territorial pair and single owl site centers	% territorial pair and single owl site centers
-2.0 - 0.0	28	36
0.0 - 2.0	17	22
2.1 - 4.0	8	10
4.1 - 6.0	5	6
6.1 - 8.0	6	8
8.1 - 10.0	5	6
10.1 - 12.0	2	3
> 12.0	7	9
total	78	100

Table 4.3.3: Summary of habitat conditions within a median home range radius of spotted owl site centers that are influenced by DNR-managed lands. Presented as the proportion of owl circle that is classified as habitat

In the eastern Washington Cascades the radius of owl circles is 1.8 miles. Pairs are status 1 and 2 site centers, and singles are status 3 centers.

% of circle as habitat	Number of site centers	% of site centers
0.0 - 10.0	pairs 1 singles 1	3
10.1 - 20.0	pairs 4 singles 0	5
20.1 - 30.0	pairs 16 singles 3	24
30.1 - 40.0	pairs 16 singles 1	22
40.1 - 50.0	pairs 15 singles 1	21
50.1 - 60.0	pairs 12 singles 0	15
60.1 - 70.0	pairs 3 singles 2	6
70.1 - 80.0	pairs 2 singles 0	3
80.1 - 90.0	pairs 0 singles 1	1
90.1 - 100.0	none	0
total	pairs 69 singles 9 total 78	100

Table 4.3.4: Summary of habitat conditions on DNR-managed lands within a median home range radius of spotted owl site centers. Presented as the proportion of owl circle that is DNR-managed habitat

In the eastern Washington Cascades the radius of owl circles is 1.8 miles. Pairs are status 1 and 2 circles, and singles are status 3 circles.

% of circle as DNR-managed habitat	Number of site centers	% of site centers
0.0 - 2.5	pairs 30 singles 5	45
2.6 - 5.0	pairs 13 singles 0	17
5.1 - 10.0	pairs 12 singles 2	18
10.1 - 20.0	pairs 4 singles 1	6
20.1 - 30.0	pairs 6 singles 1	9
30.1 - 40.0	pairs 3 singles 0	4
40.1 - 50.0	pairs 1 singles 0	1
> 50.0	none	0
total	pairs 69 singles 9 total 78	100

Some DNR-managed lands classified as owl habitat have yet to be surveyed for spotted owls. It is possible that some of this unsurveyed habitat lies within a median home range radius of unknown owl site centers. Using the ratio of surveyed to unsurveyed DNR-managed lands and the number of known site centers, we project that 23 unknown site centers exist within a median home range radius of DNR-managed lands.

One objective of both HCP alternatives is the support of spotted owls that reside on federal lands. The current distribution of owl site centers on DNR-managed lands relative to federal lands provides a base line with which to compare the impacts of the alternatives. The number of owl circles that contain DNR-managed lands decreases as the distance from federal reserves increases (Table 4.3.2). Almost 60 percent of circles containing DNR-managed lands lie within 2 miles of federal reserves, and only 12 percent occur at distances over 10 miles from federal reserves. Notably, over one-third of circles that affect DNR-managed lands have their site centers on federal land.

The U.S. Fish and Wildlife Service's (USFWS) rescinded guidelines for the avoidance of incidental take (USDI 1990) of spotted owls stipulate that at least 40 percent of the area within a median annual home range radius of a site center should be maintained as owl habitat. For owl circles affected by DNR-managed lands, the average amount of owl habitat per circle is 39 percent (Table 4.3.3). About half of the owl circles affected by DNR-managed lands circumscribe an area containing less than 40 percent habitat -- the median value is 39 percent habitat. Six contain less than 20 percent habitat. In the majority of cases (62 percent) DNR-managed habitat comprises 5 percent or less of the area within circles (Table 4.3.4). The average contribution of DNR-managed habitat per owl circle is 7.4 percent of a circle's area.

Amount and Distribution of Suitable Spotted Owl Habitat. An accurate accounting of spotted owl habitat on DNR-managed lands is not available. Only 36 percent of DNR-managed lands in the east-side planning units have owl habitat field survey data which is validated by WDFW. Landsat Thematic Mapper images collected in 1988 were used to classify the other 64 percent as either spotted owl habitat or non-habitat. The construction of habitat maps is explained in Appendix D. The WDFW validated data were used to calculate the empirical probability of classification error. The probabilities of classification error for the east-side habitat maps were 23, 16, and 13 percent for the Chelan, Yakima, and Klickitat planning units, respectively. The majority of errors were habitat omission errors, i.e., some forests that were field-typed as habitat were classified as non-habitat on the habitat map. Therefore, the habitat maps for the east-side planning units probably underestimate the amount of spotted owl habitat that existed in 1988, but in the intervening 7 years since the Landsat images were collected, some habitat has been harvested. For the purposes of analysis, the habitat classification based on the Landsat images is assumed to be correct.

The analysis of spotted owl habitat for the west-side planning units used two estimation methods -- one based on a composite of multiple data sources and another based on DNR's timber inventory. The timber inventory could not be used in the east-side analysis because the data items in east-side timber inventory are incompatible with standard descriptions of owl habitat. Partial-cutting practices, which predominate in the eastern Washington Cascades, rely on different information than the clearcutting practices of the western Cascades. Managing stands by the partial removal of timber volume requires a database which tracks timber volume, which in DNR's inventory is expressed as board feet per acre. No data items in the inventory correspond to any variables that are typically used to describe spotted owl nesting habitat, e.g., canopy closure, mean tree diameter, or stand density. Stand age can be used as a reasonable proxy for these habitat variables, but this information is not available for most forest stands on DNR-managed lands in the east-side planning units.

There are 288,800 acres of DNR-managed lands in the east-side planning units. This is approximately 4 percent of the Eastern Washington Cascades Province. Twenty-nine percent (67,400 acres) of DNR-managed lands in the east-side planning units were classified as spotted owl habitat -- approximately 6 percent of all spotted owl habitat in the province (USDI 1992b p. 122-128; DNR 1995d). Most DNR-managed habitat (71 percent) occurs in the Klickitat Planning Unit (Table 4.3.5). The Chelan Planning Unit contains only 5,000 acres of habitat, which is 7 percent of DNR-managed owl habitat in the east-side planning units.

One objective of both HCP alternatives is the support of spotted owls that reside on federal lands. The current distribution of habitat on DNR-managed lands relative to federal lands provides a base line with which to compare alternatives. Habitat distribution was analyzed using nested 2 mile distance bands (Table 4.3.6). The amount of DNR-managed lands that have been classified as spotted owl habitat decreases as the distance from federal reserves increases. Twenty-two percent of spotted owl habitat on DNR-managed lands in the east-side planning units lies within 2 miles of federal reserves, but only 3 percent lies between 10 and 12 miles from federal reserves. Over half of the spotted owl habitat on DNR-managed lands in the east-side planning units lies within 6 miles of federal reserves. Per distance band, habitat density on DNR-managed lands is fairly uniform out to a distance of 8 miles from federal reserves. The density fluctuates around 30 percent plus or minus 4 percent.

79,900 acres (35 percent) of DNR-managed lands lie within status 1, 2, or 3 owl circles (Table 4.3.7). Approximately two-thirds of this land is located in the Klickitat Planning Unit. The Chelan Planning Unit has only 4,400 acres of DNR-managed lands in owl circles, which is 6 percent of all DNR-managed lands in the east-side planning units that are affected by circles. About half of all forests on DNR-managed lands classified as owl habitat lie within owl circles (Table 4.3.7). This proportion is roughly the same across all east-side planning units.

The proportion of east-side DNR-managed lands within owl circles is greatest near federal reserves and decreases as the distance from federal reserves increases (Table 4.3.8). Approximately one-third of DNR-managed lands in circles lies within 2 miles of federal reserves. A similar relationship holds for the proportion of DNR-managed lands classified as owl habitat.

Approximately 50 percent of DNR-managed lands within 2 miles of federal reserves is situated in an owl circle (Table 4.3.8). Beyond 2 miles from federal reserves, the proportion of DNR-managed lands in owl circles per distance band varies between 25 and 40 percent. Within 2 miles of federal reserves, two-thirds of DNR-managed lands classified as owl habitat is situated in circles, and beyond 2 miles the proportion per distance band varies between 40 and 55 percent. Apparently, about half of DNR-managed lands classified as owl habitat is not used by owls. This surprising result may be due to several factors: (1) forests may be misclassified as habitat; (2) forests correctly classified as owl habitat may not have been surveyed for owls or surveys have failed to detect owls that were present; (3) some DNR-managed parcels classified as habitat are highly fragmented and unsuitable for owls; (4) some parcels may provide suitable habitat but are isolated by distance and habitat fragmentation; or, (5) unoccupied suitable habitat is symptomatic of population decline.

Table 4.3.5: Total DNR-managed lands and DNR-managed lands classified as spotted owl habitat by planning unit

See Appendix D for explanation of GIS spotted owl habitat classification.

HCP Planning Unit	Acres DNR-managed lands	Acres DNR-managed lands classified as suitable owl habitat	% DNR-managed lands classified as suitable owl habitat in unit	% total east-side DNR-managed lands classified as suitable owl habitat
Chelan	15,700	5,000	32	7
Yakima	80,700	14,900	19	22
Klickitat	132,400	47,500	36	71
totals	228,800	67,400	29	

Table 4.3.6: Spatial distribution relative to federal reserves of DNR-managed lands and DNR-managed lands classified as owl habitat

See Appendix D for explanation of GIS spotted owl habitat classification.

Distance from federal reserves (miles)	Acres DNR-managed lands	Acres DNR-managed lands classified as suitable owl habitat	% DNR-managed lands classified as suitable owl habitat in distance band	% total east-side DNR-managed lands classified as suitable owl habitat
0.0 - 2.0	46,400	15,100	33	22
2.1 - 4.0	43,700	11,200	26	17
4.1 - 6.0	45,800	15,400	34	23
6.1 - 8.0	37,300	10,300	28	15
8.1 - 10.0	19,000	3000	16	4
10.1 - 12.0	8,700	2,100	24	3
> 12.0	27,800	10,400	37	15
total	228,700	67,500	28	99

Table 4.3.7: DNR-managed lands currently in owl circles by planning unit

See Appendix D for explanation of GIS spotted owl habitat classification. See Table 4.3.5 for total acres of DNR-managed lands and DNR-managed habitat.

HCP Plannin g Unit	Acres DNR-managed lands in owl circles	% DNR-managed lands in unit	% of east-side DNR-managed lands in owl circles	Acres DNR-managed lands classified as owl habitat in owl circles	% DNR-managed lands classified as owl habitat in unit	% of east-side DNR-managed lands classified as owl habitat in owl circles
Chelan	4,400	28	6	2,500	50	7
Yakima	20,800	26	26	5,900	40	17
Klickitat	54,700	41	68	26,200	55	76
totals	79,900	35	100	34,600	51	100

Table 4.3.8: Spatial distribution relative to federal reserves of DNR-managed lands currently in owl circles

See Appendix D for explanation of GIS habitat classification. See Table 4.3.6 for total acres of DNR-managed lands and DNR-managed habitat.

Distance from federal reserves (miles)	Acres DNR-managed lands in owl circles	% DNR-managed lands in distance band	% of east-side DNR-managed lands in owl circles	Acres DNR-managed lands classified as owl habitat in owl circles	% DNR-managed lands classified as owl habitat in distance band	% of east-side DNR-managed lands classified as owl habitat in owl circles
0.0-2.0	24,400	53	31	10,100	67	29
2.1-4.0	14,600	34	18	4,600	41	13
4.1-6.0	12,100	26	15	6,600	43	19
6.1-8.0	9,800	26	12	5,600	54	16
8.1-10.0	5,000	26	6	1,500	50	4
10.1-12.0	3,200	37	4	900	44	3
> 12.0	10,800	39	14	5,400	52	16
totals	79,900	35	100	34,700	51	100

Evaluation of Alternatives

Criterion 1 -- Amount and Distribution of NRF Habitat

The analysis of the amount and spatial distribution of spotted owl habitat was simplified for the east-side planning units. Only one method of habitat estimation was used, and simulations of timber harvest and forest growth were not used to estimate the amount of owl habitat over time. Such projections are useful for assessing impacts but require a model that relates the information recorded in the timber inventory to variables describing habitat. The present state of knowledge does not allow a reasonably accurate projection of owl habitat over time. The immediate short-term harvest and the expected long-term outcomes of each alternative were estimated and used to compare alternatives.

For the purposes of this analysis, it was assumed that no habitat would be lost to natural disturbance. The management of riparian zones and unstable hillslopes is the same under all alternatives and so the potential contributions of such management to spotted owl habitat were ignored in the analysis. There is no mention of the marbled murrelet conservation strategies because they do not extend to the east-side planning units.

ALTERNATIVE A

All owl habitat outside of spotted owl circles will eventually be harvested. Management for spotted owls will continue on a circle-by-circle basis. No new habitat would be allowed to develop in circles that are below the 40 percent minimum, and any habitat lost to natural or human-caused disturbance would not be replaced. The geographical shift of a site center alters the location of its owl circle, and this may release owl habitat for harvest. Habitat lost in this manner was not considered in the analysis. Generally, when an owl circle possessing more then 40 percent habitat is established, private landowners mobilize to harvest any owl habitat which they manage. Harvest of habitat down to the 40 percent level quickly occurs and DNR is prevented from harvesting owl habitat under its management. Therefore, it was assumed that in owl circles containing less than 40 percent habitat on federal reserves, DNR would be unable to harvest owl habitat. In circles with at least 40 percent habitat on federal reserves, DNR would harvest all of its owl habitat.

Methods. Projections for the spatial distribution of habitat were made by planning unit and by distance band from federal reserves. Similar calculations were done for both the planning unit and distance band projections. The projected unknown owl site centers were distributed among planning units (or distance bands) according to the proportion of east-side unsurveyed habitat in the planning unit. For example, the Klickitat Planning Unit has 56 percent of DNR-managed unsurveyed habitat in the east-side planning units. It was assigned 12 of the 23 projected unknown owls. An assumption of this method is that unsurveyed habitat in each planning unit is equally likely to support territorial spotted owls. This is a weak assumption. Nevertheless, the method used for distributing unknown site centers should be sufficient for the purposes of this analysis. The average amount of DNR-managed habitat per owl circle (440 acres) times the number of projected unknown site centers was added to the amount unavailable for harvest. Only three owl circles in the east-side planning units contain at least 40 percent habitat that is on federal reserves. A total of 300 acres of habitat were available for harvest in these circles. Two of these circles are located in the Chelan Planning Unit and one circle occurs in the Yakima Planning Unit. Appropriate amounts of habitat were subtracted from each planning unit. All 300 acres were subtracted from habitat in the 0.0-2.0 mile distance band.

Results. Approximately 67,400 acres of DNR-managed lands have been classified as owl habitat in the east-side planning units, and 34,600 acres of this habitat are within a status 1, 2, or 3 owl circle (Tables 4.3.7 and 4.3.9). According to the above assumptions, most of the habitat within owl circles, 34,300 acres, is unavailable for harvest. The estimated amount of owl habitat protected within the 23 projected unknown site centers is 10,100 acres. In total, 44,400 acres of owl habitat are projected to be unavailable for harvest, and constitute the total amount of spotted owl habitat on DNR-managed lands over the short term. Under this alternative the total amount of spotted owl habitat is projected to decline by 34 percent. This moderate change in the projected amount of owl habitat can be attributed to habitat protected around unknown site centers. An owl habitat projection using only known site centers results in a negative 49 percent change in habitat. The actual reduction in habitat is likely to lie between these two figures. It is likely that over the long term the amount of owl habitat on DNR-managed lands will decline below the amounts projected because of continual natural disturbance and shifts in site centers.

Under Alternative A, most harvest of habitat (70 percent) occurs in the Klickitat Planning Unit (Table 4.3.12). Spotted owl habitat is most severely impacted in the Yakima Planning Unit where 44 percent of DNR-managed habitat is projected to be harvested. Within 2 miles of federal reserves the projected change in habitat is negative 21 percent (Table 4.3.13). Beyond 12 miles the projected change is negative 14 percent. This small change in the projected amount of owl habitat can be attributed to the habitat protected around unknown site centers. The same projection using only known site centers results in a negative 48 percent change in habitat beyond 12 miles from federal reserves. Between 2 and 12 miles the change in the amount of habitat per distance band ranges between negative 35 and negative 50 percent.

Table 4.3.9: Alternative A: DNR-managed forest classified as spotted owl habitat available for harvest in the three east-side planning units

Habitat	Acres
Forest classified as owl habitat	67,400
Forest classified as owl habitat outside owl circles	32,800
Forest classified as owl habitat in owl circles available for harvest	300
Forest classified as owl habitat within projected unknown owl circles unavailable for harvest	10,100
Total owl habitat available for harvest	23,000
Owl habitat remaining after harvest	44,400

ALTERNATIVE B

Approximately 39,200 acres would be managed for spotted owl nesting, roosting, and foraging habitat (Table 4.3.10; Maps 23-27). At least 50 percent of the DNR-managed lands designated for NRF management would be in NRF habitat at any one time. The 50 percent habitat prescription would be applied to watershed administrative units (WAUs). In WAUs where federal reserves are covered by less than 50 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attained a minimum of 50 percent habitat.

Results. There are 19,400 acres of DNR-managed lands classified as spotted owl habitat in the east-side NRF management areas. This leaves 48,000 acres of habitat outside of NRF management areas available for immediate harvest (Table 4.3.11). There are 35 WAUs that contain DNR-managed lands designated as NRF management areas. At present, five of these WAUs are above their habitat target and thus have owl habitat available for harvest. Only 2,100 acres of owl habitat are available for harvest in NRF management areas. Therefore, under this alternative, the short-term change in the amount of spotted owl habitat is projected to be 50,100 acres, a negative 74 percent change.

The current amount of DNR-managed lands classified as spotted owl habitat in the east-side NRF management areas is 99 percent of the total target amount (19,600 acres). The projected short-term harvest will reduce this to 88 percent of the total target amount. Over the next 100 years, all WAUs within NRF management areas should attain the 50 percent habitat target at which time the overall net change in habitat will be negative 71 percent (Table 4.3.12).

The long-term habitat targets specified for NRF management areas were used to estimate change in the distribution of habitat. Under Alternative B, most harvest of habitat occurs in the Klickitat Planning Unit (Table 4.3.12). Over three-quarters of all habitat harvest occurs there. Also, spotted owl habitat is most severely impacted in this planning unit where 79 percent of DNR-managed habitat is projected to be harvested. Within 2 miles of federal reserves the projected change in habitat is negative 11 percent (Table 4.3.13). The amount of habitat within 2 miles of federal reserves is 33 percent greater than what is currently protected in owl circles (Table 4.3.8) and 12 percent greater than what is projected to be protected under Alternative A (Table 4.3.13). Beyond 2 miles the change in the amount of habitat per distance band is much greater, ranging between negative 67 and negative 100 percent.

Discussion. The amount of owl habitat available for immediate harvest under Alternative B is much greater than that available under Alternative A, but the long-term certainty associated with the maintenance of owl habitat is also greater for Alternative B. A key assumption used for the analysis of Alternative A could be invalidated by changes in agency policy. DNR could conduct protocol surveys to decertify (i.e., change to historic status) existing owl circles. Any owl habitat on DNR-managed lands within decertified owl circles would be available for harvest. Also, it is worth reiterating that under Alternative A any habitat lost to natural or human-caused disturbance would not be replaced, and that geographical shifts of a site center may release owl habitat for harvest. The amount of suitable owl habitat on DNR-managed lands under Alternative A will decrease below the amounts estimated, but the amount and rate of habitat loss depends on factors that are difficult to model. These uncertainties do not exist for Alternative B.

The risk to spotted owl habitat from natural disturbance may put the differences between A and B in perspective. The eastern Cascades are prone to large wildfires, and spotted owl nesting habitat possesses the ideal structural characteristics for stand-replacing fires -- a multi-layered canopy and plentiful down woody debris. Agee and Edmonds (1992) concluded that there is a very low probability that federal reserves in the east Cascades subregion will avoid catastrophic wildfires during the next century. The frequency of occurrence for large stand-replacing fires in the eastern Cascades is between 10 and 20 years. Over 100 years, the proposed term of the HCP, the number of such fires could range from 5-10. Recent wildfire history in the eastern Washington Cascades illustrates the risk to owl habitat in the coming decades: in 1988 the Dinkleman fire (Chelan

County) covered 50,000 acres; in 1992 the Skookum fire (Klickitat County) covered 51,000 acres; and, in 1994, the Tyee and Hatchery fires (Chelan County) covered 135,000 and 43,000 acres, respectively (DNR and Washington Department of Community, Trade and Economic Development 1994; DNR 1994b). Not all acres burned were owl habitat, and not all owl habitat burned was destroyed. Nevertheless, the total acreage burned in less than one decade in the eastern Washington Cascades is four times the amount of owl habitat currently under DNR management. If the amount of owl habitat lost under Alternative A were to average 2,000 acres/decade, then over 100 years, the proposed term of the HCP, the amount of owl habitat remaining under Alternative A would equal the amount of habitat maintained under Alternative B. Furthermore, the habitat remaining under Alternative A could be highly fragmented and of little value to territorial owls.

There is a trade-off between Alternatives A and B, and this trade-off is pivotal to the comparison of alternatives. Alternative A is projected to retain more of the currently existing owl habitat (Table 4.3.13), but the spatial arrangement of habitat, in particular that which remains over the long term, is unknown and difficult to predict. On the other hand, Alternative B removes more habitat, but the spatial arrangement of remaining habitat, and habitat to be developed, is known and the product of a conservation plan. It is likely that under Alternative A, owl habitat on DNR-managed lands will become more fragmented and less capable of supporting spotted owls. It is likely that owl habitat on private lands will continue to be lost, thereby isolating DNR-managed habitat. Alternative B concentrates owl habitat in proximity to federal reserves, and it is likely that this habitat will support territorial spotted owls.

ALTERNATIVE C

Approximately 93,900 acres would be managed for spotted owl nesting, roosting, and foraging habitat (Table 4.3.10; Maps 23, 25, and 27). In the Chelan and Yakima planning units, the area designated for NRF management is the same as Alternative B, but it is substantially larger in the Klickitat Planning Unit. At least 60 percent of the NRF management area would be in NRF habitat at any one time. The 60 percent habitat prescription would be applied to watershed administrative units (WAUs). In WAUs where federal reserves are covered by less than 60 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attained a minimum of 60 percent habitat.

Results. There are 41,600 acres of DNR-managed lands classified as spotted owl habitat in the east-side NRF management areas. This leaves 25,800 acres of habitat outside of NRF management areas available for immediate harvest (Table 4.3.11). There are 52 WAUs that contain DNR-managed lands designated as NRF management areas. Only one of these WAUs is above its habitat target and thus has owl habitat available for harvest. Only 100 acres of owl habitat are available for harvest in NRF management areas. Therefore, under this alternative, the short-term change in the amount of spotted owl habitat is projected to be negative 38 percent.

The current amount of DNR-managed lands classified as spotted owl habitat in the east-side NRF management areas is 74 percent of the total target amount (56,300 acres). The projected short-term harvest will reduce the amount of habitat in NRF management areas by approximately 100 acres. Over the next 100 years, all WAUs within NRF management areas should attain the 60 percent habitat level at which time the overall net change in habitat will be negative 16 percent.

Under Alternative C, most harvest of habitat occurs in the Yakima Planning Unit (Table 4.3.12). Over 60 percent of all habitat harvest occurs there. Also, spotted owl habitat is most severely impacted in this planning unit where 46 percent of DNR-managed habitat is projected to be harvested. Within 2 miles of federal reserves the amount of owl habitat increases by 7 percent (Table 4.3.13). Beyond 2 miles the amount of habitat per distance band changes between negative 60 and positive 50 percent.

Discussion. All three alternatives result in the loss of spotted owl habitat, but the smallest reduction in habitat occurs under Alternative C. In fact, in some parts of the province, Alternative C actually increases the amount of habitat on DNR-managed lands. In addition, there is a high level of certainty associated with the maintenance of this habitat. Any habitat lost to catastrophic disturbance in NRF management areas would be redeveloped.

Table 4.3.10: NRF management areas by planning unit

See Table 4.3.6 for acres of DNR-managed lands in planning units.

	Alternative B			Alternative C		
HCP Planning Unit	**Acres NRF Management Areas**	**% DNR-managed land in unit**	**% of east-side NRF Management Areas**	**Acres NRF Management Areas**	**% DNR-managed land in unit**	**% of east-side NRF Management Areas**
Chelan	5,600	36	14	5,600	36	6
Yakima	13,600	17	35	13,600	17	14
Klickitat	19,900	15	51	74,700	56	80
Total	39,100	17	100	93,900	41	100

Table 4.3.11: HCP Alternatives: DNR-managed forest classified as spotted owl habitat available for harvest in the three east-side planning units

	Alternative B (acres)	Alternative C (acres)
Forest classified as owl habitat	67,400	67,400
Forest classified as owl habitat outside NRF Management Areas	48,000	25,800
Forest classified as owl habitat available for harvest in NRF Management Areas	2,100	100
Total owl habitat available for harvest	50,100	25,900
Owl habitat remaining after harvest	17,300	41,500

Table 4.3.12: Comparison of Alternatives. Projected change in the spatial distribution of spotted owl habitat by planning unit

		Alternative A		Alternative B		Alternative C	
HCP Planning Unit	**Acres currently classified as owl habitat**	**Projected acres of owl habitat**	**% change in owl habitat**	**Projected acres of owl habitat**	**% change in owl habitat**	**Projected acres of owl habitat**	**% change in owl habitat**
Chelan	5,000	4,500	-10	2,800	-44	3,400	-32
Yakima	14,900	8,400	-44	6,800	-54	8,100	-46
Klickitat	47,500	31,500	-34	10,000	-79	44,800	-6
totals	67,400	44,400	-34	19,600	-71	56,300	-16

Table 4.3.13: Comparison of Alternatives. Projected change in the spatial distribution of spotted owl habitat by distance band

		Alternative A		Alternative B		Alternative C	
Distance from federal reserves (miles)	Acres currently classified as owl habitat	Projected acres of owl habitat	% change in owl habitat	Projected acres of owl habitat	% change in owl habitat	Projected acres of owl habitat	% change in owl habitat
0.0 - 2.0	15,100	12,000	-21	13,400	-11	16,100	+7
2.1 - 4.0	11,200	5,900	-47	2,700	-76	4,400	-61
4.1 - 6.0	15,400	7,900	-49	2,200	-86	8,500	-45
6.1 - 8.0	10,300	6,500	-37	1,200	-88	7,600	-26
8.1 - 10.0	3,000	1,900	-37	100	-67	4,300	+43
10.1 - 12.0	2,100	1,300	-38	0	-100	3,200	+52
> 12.0	10,400	8,900	-14	0	-100	12,300	+18
total	67,500	44,400	-34	19,600	-71	56,400	-16

Criterion 2 -- Impacts to Spotted Owl Site Centers

The number of spotted owl site centers impacted by each of the alternatives was examined in two different ways. First, the impacts to known site centers and projected unknown site centers were assessed using the rescinded take-avoidance guidelines issued by USFWS (USDI 1990). See Section 4.2.1 for a discussion of assumptions regarding the rescinded take-avoidance guidelines. Second, the impacts of each alternative to future site centers was assessed using the latest estimates of the population's demographic parameters and assumptions about owl habitat on federal reserves.

Impacts to Current Owl Site Centers

Economic considerations would motivate DNR to rapidly harvest owl habitat released from the USFWS rescinded take-avoidance guidelines. Therefore, it was assumed that under an HCP any incidental take of known and projected unknown site centers that might occur would occur within the first decade. It was also assumed that during the first decade the number of site centers is static. As described below this assumption may overestimate the number of site centers affected by DNR management. Furthermore, it was assumed that over the term of the HCP a given site center can be taken once and only once.

ALTERNATIVE A

DNR continues its policy of take-avoidance, and it is assumed that by adhering to the USFWS rescinded take-avoidance guidelines (USDI 1990), adverse impacts to individual spotted owl site centers will be minimal. Strictly speaking, there would be no incidental take. While this assumption accurately represents the adverse impacts of DNR's harvest activities, it ignores the impacts of neglect. Thirty-six known site centers are within owl circles containing between 20 and 40 percent habitat (Table 4.3.3). Under Alternative A, no new habitat would be allowed to develop in these circles, and any habitat lost to natural or human-caused disturbance would not be replaced. Marginally viable site centers such as these may support territorial owls, but over time, habitat conditions surrounding many of them are expected to deteriorate. Inevitably, many of these sites would be incapable of supporting territorial owls. Fifteen owl circles contain between 20 and 40 percent habitat and contain more than 40 percent federal reserves. Young forests on federal reserves are developing into owl habitat. The likelihood of persistence for these site centers mainly depends on habitat conditions on nearby federal landscapes. If an adequate amount of owl habitat does not develop in the near future, then these sites may not persist over the long term.

Some site centers are unlikely to be occupied by territorial owls. An analysis by Bart and Forsman (1992) showed that spotted owls are very rarely found in landscapes dominated by younger forest (less 80 years old). All measures of owl abundance were significantly lower on areas with less than 20 percent older forest. Six of the 78 known site centers are within owl circles containing less than 20 percent habitat. To assess the real impacts of the alternatives it is reasonable to assume that these site centers do not have territorial owls. There are six known site centers within owl circles containing less than 20 percent habitat. In summary, under Alternative A, as many as 27 known site centers are likely to be lost and 15 others may eventually be incapable of supporting territorial spotted owls (Table 4.3.14).

It is likely that some site centers capable of supporting territorial spotted owls, i.e., those with more than 40 percent habitat in their owl circle, will be unoccupied. This statement is supported by evidence which suggests that the spotted owl population in the Eastern Washington Cascades Province is shrinking in size. Furthermore, as demonstrated below, the spotted owl population could continue to decline for another 20-50 years. Burnham et al. (1994) estimated λ, the finite rate of population change, for one demographic study area in the eastern Washington Cascades -- the Cle Elum study area. The estimated value of λ for this area was 0.924, a negative 7.6 percent annual rate of change. In the calculation of λ, juvenile survivorship is the parameter with the greatest uncertainty. Banded juveniles that survive the year, emigrate from the study area, and not reobserved during the next census are counted as dead. Hence, juvenile emigration can lead to an underestimate of juvenile survivorship. Using radio-tracking data a more accurate estimate of juvenile survivorship which includes emigration can be calculated. Adjusting the Cle Elum juvenile survivorship for emigration (using E = 0.3158 from Burnham et al. 1994) yields a λ equal to 0.957, a negative 4.3 percent annual rate of change. As discussed in USDA and USDI (1994a p. 3&4-233), such rapid rates of change are inconsistent with observations. The 95 percent confidence interval for λ from the Cle Elum study area is [0.861, 0.987]. The upper limit, which equals a negative (-) 1.3 percent annual rate of change, is more consistent with observations of owl densities (USDA and USDI 1994a). There are 72 known site centers with more than 20 percent habitat in their owl circle and thus likely to be currently occupied. Applying the estimated annual rate of change over one decade suggests that the number of occupied site centers in 2006 could be approximately 63.

Table 4.3.14: Projected impacts to known spotted owl site centers under Alternative A, the No Action alternative

Amount of habitat in owl circle / amount of federal reserve in circle	Alternative A (owl site centers)	Impacts to spotted owl site centers from DNR management
less than 20% habitat	6	unlikely to support territorial owls
between 20% and 40% habitat / less than 40% federal reserves	21	unlikely to persist
between 20% and 40% habitat / greater than 40% federal reserves	15	may not persist
greater than 40% habitat / less than 40% federal reserves	23	likely to persist over the short term
greater than 40% habitat / greater than 40% federal reserves	13	very likely to persist over the long term
Total	78	

Owl site centers were divided into two groups -- centers with owl circles completely outside of NRF management areas and centers with owl circles overlapping NRF management areas. For owl circles completely outside of NRF management areas, it was assumed that all DNR-managed habitat would be harvested. For owl circles overlapping NRF management areas, it is was assumed that any habitat outside NRF management areas would be harvested and that inside NRF management areas owl habitat in excess of the 50 percent habitat target would be harvested.

Methods. Impacts to site centers in circles outside of NRF management areas were divided into five categories. First, there are circles that contain DNR-managed lands but no DNR-managed owl habitat. According to the rescinded take-avoidance guidelines, DNR management activities have no or minimal adverse impact. The second category is circles that have less than 40 percent habitat, but the DNR-managed habitat comprises less than 1 percent of the circle's total area. Harvest of DNR-managed habitat within these circles might be considered incidental take, but the impacts to territorial owls within these circles would likely be minimal. The third category is owl circles that have less than 40 percent habitat, and DNR-managed habitat comprises more than 1 percent of the circle's total area. Harvest of owl habitat in these circles could be construed as incidental take and the adverse impacts to owls may be significant. Fourth, circles that have greater than 40 percent habitat and in which DNR may harvest habitat to a level below 40 percent fall into another incidental take category. Fifth, the potential for future take exists where a circle has greater than 40 percent habitat, most habitat is on private lands, and a smaller amount on DNR-managed lands. Over time, private landowners could harvest timber up to the 40 percent habitat level before DNR removed its timber. Consequently, although the current condition of the circle indicates that DNR could harvest all its habitat without the incidental take of owls, the habitat conditions could change such that take could occur.

Impacts to site centers in circles overlapping NRF management areas were divided into five categories. The first category is circles that have less than 40 percent habitat and no DNR-managed habitat available for harvest. The habitat is unavailable for harvest because DNR-managed lands in the owl circle are below the 50 percent habitat target specified by Alternative B. The second category is circles that have less than 40 percent habitat, but the DNR-managed habitat available for harvest comprises less than 1 percent of the circle's total area. Harvest of any habitat with these circles might be considered incidental take, but the impacts to territorial owls within these circles would likely be minimal. The third category is owl circles that have less than 40 percent habitat, and DNR-managed habitat available for harvest comprises more than 1 percent of the circle's total area. Harvest of owl habitat in these circles could be construed as incidental take and may have a significant adverse impact to owls. Circles were placed in a fourth category if they had greater than 40 percent habitat and DNR management did not reduce the amount of habitat below 40 percent. The fifth category contains circles that have greater than 40 percent habitat and DNR's management reduces the proportion of habitat below 40 percent. This could be construed as incidental take.

Projected unknown site centers were divided into centers with owl circles outside of NRF management areas and centers with circles overlapping NRF management areas. Site centers discovered within 2 miles of NRF management areas could have owl circles that overlap NRF management areas. Hence, the division was based on the proportion of east-side DNR-managed unsurveyed habitat that is within 2 miles of or in NRF management areas. Site centers in each of these two groups were assigned to incidental take, no take, or potential take. This was based on the proportion of known site centers in each of these take categories.

Results. Under Alternative B, 33 of the 78 known site centers do not have circles that overlap NRF management areas. The analysis indicates that timber harvest in 30 of these will exceed the rescinded USFWS take-avoidance guidelines (Table 4.3.15). Incidental take is expected for 17 of these site centers, and 10 site centers have a potential for incidental take. The only circumstances for which incidental take will certainly not occur as a result of DNR's proposed HCP is in those circles that do not contain DNR-managed habitat.

Forty-five known owl circles overlap NRF management areas. For 12 of these, incidental take is expected, and eight have the potential for incidental take (Table 4.3.16). All of the site centers expected to be or with the potential to be taken have less than 40 percent habitat in their owl circle. The majority of the incidental take occurs through the harvest of habitat outside of NRF management areas.

A total of 39 site centers, known and projected unknown, are expected to be taken under Alternative B (Table 4.3.18). An additional 24 site centers have the potential to be taken. Therefore, a maximum of 63 site centers are at risk for incidental take.

Discussion. Alternative B puts a large number of site centers at risk for take. The significance of this incidental take should be assessed in the context of current habitat conditions and the likelihood that these site centers will be occupied by territorial spotted owls now or in the future. Of the 47 known site centers taken or having the potential to be taken, six are located in an owl circle containing less than 20 percent owl habitat. As discussed above, these sites are unlikely to be occupied. Also, of the 47 known site centers taken or having the potential to be taken, 30 are within owl circles containing between 20 and 40 percent habitat. Marginally viable site centers such as these may support territorial owls, but over time, habitat conditions surrounding many of them are expected to deteriorate. Inevitably many of these sites would be incapable of supporting territorial owls. In effect, 44 known site centers with a reasonable likelihood to be occupied are at risk for take, and for all but 14 of these long-term persistence is questionable.

Spotted owl population trends further enrich the context in which to assess the significance of incidental take. Alternative B places 42-66 site centers at risk for take, but the number of occupied site centers at risk for take should be less than projected. This statement is supported by evidence which suggests that the spotted owl population in the Eastern Washington Cascades Province is shrinking in size, as described above. Since the population in the Eastern Washington Cascades Province is declining, some site centers, even those capable of supporting territorial owls, are unlikely to be occupied in the future. Applying the estimated annual rate of change ($\lambda = 0.987$) over one decade suggests that the incidental take of occupied site centers could range from 37-58. Alternative B is projected to adversely impact between 32 and 50 known site centers, but as few as 14 of these are likely to persist over the long term. The adverse impacts to site centers are anticipated to occur over the first decade. Alternative A is a no-take alternative, so any adverse impacts to site centers occur over the long term. Between 21 and 42 site centers could suffer significant adverse impacts through habitat loss under Alternative A. Twenty-two site centers with more than 40 percent habitat and with owl circles overlapping NRF management areas are guaranteed to have some portion of their circle maintained as habitat under Alternative B. The likelihood that these site centers will persist over the long term is increased by DNR's management. In contrast, under Alternative A, for the 36 site centers with more than 40 percent habitat DNR's management decreases the likelihood that these site centers will persist (Table 4.3.14). This is particularly true for the 23 site centers with less than 40 percent federal reserves within their owl circle. Over the short term, Alternative A should cause fewer significant adverse impacts to spotted owl site centers, but over the long term Alternative B should cause fewer significant adverse impacts.

ALTERNATIVE C

The methods used to analyze Alternative C were the same as those for Alternative B, except the habitat target for NRF management areas was 60 percent.

Results. Fourteen of the 78 known owl site centers do not have circles that overlap NRF management areas. The analysis indicates that timber harvest in 11 of these may exceed the USFWS rescinded take-avoidance guidelines (Table 4.3.15). Incidental take is expected for five of these site centers, and six site centers have a potential for incidental take. The only circumstances for which incidental take will certainly not occur is in those circles that do not contain DNR-managed habitat.

Sixty-four known owl circles overlap NRF management areas. In four of these, incidental take is expected, and 18 have the potential for incidental take (Table 4.3.16). All of the site centers expected to be or with the potential to be taken have less than 40 percent habitat in their owl circles. All incidental take occurs through the harvest of habitat outside of NRF management areas.

A total of 11 site centers, known and projected unknown, are expected to be taken under Alternative C (Table 4.3.18). An additional 31 site centers have the potential to be taken. Therefore, a maximum of 42 site centers are at risk for incidental take.

Discussion. Alternative C puts a large number of site centers at risk for take. The significance of this incidental take should be assessed in the context of current habitat conditions and the likelihood that these site centers will be occupied by territorial spotted owls now or in the future. Of the 33 known site centers taken or having the potential to be taken, six are located in an owl circle containing less than 20 percent owl habitat. As discussed above, these sites are unlikely to be occupied. Also, of the 33 known site centers taken or having the potential to be taken, 23 are within owl circles containing between 20 and 40 percent habitat. Marginally viable site centers such as these may support territorial owls, but over time, habitat conditions surrounding many of them are expected to deteriorate. Inevitably many of these sites would be incapable of supporting territorial owls. In effect, 27 known site centers with a reasonable likelihood to be occupied are at risk for take, and for all but four of these, long-term persistence is questionable.

Alternative C is projected to adversely impact between nine and 33 known site centers, but as few as four of these are likely to persist over the long term. The adverse impacts to site centers are anticipated to occur over the first decade. Alternative A is a no-take alternative, so any adverse impacts to site centers occur over the long term. Between 21 and 42 site centers could suffer significant adverse impacts through habitat loss under Alternative A. Thirty-two site centers with more than 40 percent habitat and with owl circles overlapping NRF management areas are guaranteed to have some portion of their circle maintained as habitat under Alternative C. The likelihood that these site centers will persist over the long term is increased by DNR's management. In contrast, under Alternative A, for the 36 site centers with more than 40 percent habitat, DNR's management decreases the likelihood that these site centers will persist (Table 4.3.14). This is particularly true for the 23 site centers with less than 40 percent federal reserves within their owl circle. Over the short term, Alternative A should cause fewer significant adverse impacts to spotted owl site centers, but over the long term Alternative C should cause fewer significant adverse impacts.

Table 4.3.15: Assessment of incidental take of spotted owl site centers that have owl circles outside of proposed NRF management areas for the east-side planning units

Amount of habitat in owl circle / contribution of DNR-managed lands	Alternative B (site centers)	Alternative C (site centers)	Impacts to spotted owl site centers from DNR management
no habitat on DNR-managed lands	3	3	No take
less than 40% habitat / DNR-managed habitat < 1% of circle	3	3	Potential incidental take, but impacts likely to be minimal
less than 40% habitat / DNR-managed habitat > 1% of circle	12	4	Incidental take
greater than 40% habitat / DNR manages more habitat than margin above 40%	5	1	Incidental take
greater than 40% habitat / less than 40% habitat on federal reserves / DNR manages less habitat than margin above 40%	7	3	Potential incidental take in future
Totals	17	5	
incidental take	10	6	
potential incidental take	3	3	
no take	33	14	
total			

Table 4.3.16: Assessment of incidental take of spotted owl site centers that have owl circles overlapping the proposed NRF management areas for the east- side planning units

Amount of Habitat in owl circle / contribution of DNR-managed lands	Alternative B (site centers)	Alternative C (site centers)	Impacts to spotted owl site centers from DNR management
less than 40% habitat / No habitat available for harvest	3	10	No take
less than 40% habitat / DNR-managed habitat available for harvest less than 1% of circle	8	18	Potential incidental take, but impacts likely to be minimal
less than 40% habitat / DNR-managed habitat available for harvest greater than 1% of circle	12	4	Incidental take
greater than 40% habitat / DNR management does not reduce habitat below 40%	22	32	No take
greater than 40% habitat / DNR management reduces habitat below 40%	0	0	Incidental take
Totals:			
incidental take	12	4	
potential incidental take	8	18	
no take	25	42	
total	45	64	

Table 4.3.17: Assessment of incidental take of projected unknown spotted owl site centers for the east-side planning units

Unknown site centers were assigned to take categories according to the proportion of known site centers in each take category. See Tables 4.3.15 and 4.3.16.

	Alternative B (site centers)	Alternative C (site centers)
Owl circles outside of NRF Management Areas:		
incidental take	7	1
potential incidental take	4	1
no take	1	1
Owl circles overlapping NRF Management Areas:		
incidental take	3	1
potential incidental take	2	6
no take	6	13
Totals		
incidental take	10	2
potential incidental take	6	7
no take	7	14
total	23	23

Table 4.3.18: Summary of incidental take for owl circles outside of NRF Management Areas, owl circles overlapping NRF Management Areas, and projected unknown site centers

Totals	Alternative B (site centers)	Alternative C (site centers)
incidental take	42	11
potential incidental take	24	31
no take	35	59
total	101	101

Future Impacts to Owl Site Centers

The assessment of adverse impacts to currently existing owl site centers assumed that the number of centers is static. In fact, site centers are dynamic. Population demographics affect the total number of site centers in a region, and the birth, death, and behavior of individual owls determine the persistence of individual site centers. While an assumption of stasis may provide a reasonable estimate of impacts to site centers over the first decade, the same assumption should not be extended farther into the future. This section attempts to estimate the number of owl circles overlapping NRF management areas over time after the first decade. This is not an estimate of future owl density in NRF management areas -- too many unknowns preclude a reasonable estimate. Rather, it is simply an estimate of the number of site centers that might be affected by DNR management in NRF management areas.

ALTERNATIVE A

DNR continues its policy of take-avoidance, and it is assumed that by adhering to the USFWS rescinded take-avoidance guidelines (USDI 1990), adverse impacts to individual spotted owl site centers will be minimal. Strictly speaking, there would be no incidental take. As explained above, while this assumption accurately represents the adverse impacts of DNR's harvest activities, it ignores the impacts of neglect. Because of the continual loss of owl habitat and negative population trends it is expected that the number of site centers affected by DNR-managed lands will continually decline. As explained below, habitat conditions on federal reserves may reverse this population trend 20-50 years in the future. For the No Action alternative, the quantity and quality of owl habitat that may exist on DNR-managed and neighboring lands cannot be accurately predicted that far into the future. Even if habitat conditions surrounding site centers were to remain unchanged, population trends indicate that the number of occupied sites could decline from 72 to 63 sites over one decade.

ALTERNATIVE B

Methods. There are three simplifying assumptions for the analysis. First, after the first decade, spotted owl habitat outside of federal reserves and NRF management areas will be insufficient to support territorial owls. During the first decade DNR would harvest nearly all owl habitat outside NRF management areas and it is anticipated that private landowners would seek every opportunity to do the same. Consequently, it is unlikely that any territorial spotted owls could exist on DNR-managed and private lands that are more than a median home range radius from NRF management areas. This assumption focuses the analysis on site centers with owl circles that overlap NRF management areas.

The second assumption relies on the concept of source-sink population dynamics. Across their range, spotted owls occupy habitat that varies in quality. Source sub-populations are those which occupy areas of high quality habitat where natality exceeds mortality. Sink sub-populations occupy areas of lower quality habitat where mortality exceeds natality. In general, source sub-populations are net exporters of individuals and sink sub-populations are net importers. We anticipate that the average owl habitat conditions on federal reserves will eventually support a source sub-population of spotted owls, and that the average habitat conditions on DNR-managed lands will support a sink sub-population. Habitat conditions on federal lands are, and will continue to be, the most important factor determining the size and distribution of the spotted owl population in the eastern Washington Cascades. Federal agencies control 60 percent of the owl habitat in the Eastern Washington Cascades Province (USDI 1992b p. 122-128; DNR 1995d), and the amount of habitat on federal lands is expected to substantially increase under the President's Forest Plan (USDA and USDI 1994a p. 3&4-42). In contrast, DNR-managed lands hold only 6 percent of all spotted owl habitat in the province, and this amount will decrease under all alternatives. Certainly, habitat conditions in NRF management areas determine their spotted owl carrying capacity, but since habitat conditions in many areas are already close to their WAU target, it is the habitat conditions on federal lands that will determine the actual number of owls using NRF management areas. Therefore, the second assumption is that the number of owl circles overlapping NRF management areas will be determined by habitat conditions on federal reserves.

Third, it is assumed that the results of Burnham et al. (1994) provide a reasonable approximation of λ, the population's rate of change. They reported on the Cle Elum study area in the eastern Washington Cascades. As explained above, the 95 percent confidence interval for λ from the Cle Elum study area is [0.861, 0.987], and a λ equal to 0.987 is consistent with observations of owl densities (USDA and USDI 1994a). This value was used in the following analysis.

A model was constructed to predict the change in the number of site centers over time. In the model, the number of site centers is multiplied by λ each year. This yields the number of site centers expected in the next year. The initial value of λ is assumed to be 0.987. The value of λ increases over time as habitat develops on federal lands. Five scenarios were devised to relate λ to changes in federal habitat. Each scenario specifies a set of conditions which determine the point in time when the population should be stable, i.e., λ equals 1.0. Beyond this point in time, λ continues to increase at the same rate until federal lands reach their maximum coverage by late-successional forest. After this, λ is a constant equal to the value it attained when federal lands reached their maximum.

The first scenario is based on projections of the Interagency Scientific Committee and the Northern Spotted Owl Recovery Team (Thomas et al. 1990; USDI 1992b as discussed in USDA and USDI 1994a p. 3&4-228). Both groups believed that habitat and owls would continue to decline for up to 50 years before reaching a new equilibrium. Under this scenario λ equals 1.0 at year 50. The other four scenarios are based on a projection of habitat development presented in USDA and USDI (1994a p. 3&4-43). According to this projection, federal reserves should be 75 percent late-successional forest in 50 years, and 80 percent late-successional forest in 100 years. Eighty percent was believed to be the maximum proportion of late-successional forest that might develop on federal reserves. Federal reserves in the eastern Washington Cascades currently average 33 percent spotted owl habitat (USDA and USDI 1994a p. G-13). The four scenarios differ in the forest age and amount of habitat necessary to support a stable owl population. For example, the first scenario assumes that federal reserves will support a stable owl population when they have, on average, 60 percent forest cover that is 120 years or older. There are no data available with which to accurately determine the landscape characteristics that might support a stable population (USDA and USDI 1994a p. 3&4-231), so a range of plausible values were inserted into the model. The initial number of site centers used in the model was the number of known and projected unknown centers overlapping NRF management area not taken at the end of the first decade -- 31 site centers.

Results. The results are wide-ranging. The decline in the number of owl site centers overlapping NRF management areas could continue for 20-50 years. The number of site centers at year 50 could range from approximately 24 to 40. Based on an average of the five scenarios, the number of site centers overlapping NRF management areas may not return to the current number (56 known and unknown centers) until year 100. As discussed below, the number of site centers that may be adversely affected by DNR management each decade ranges from zero to the maximum estimated for each decade (e.g., 34 in decade four).

Discussion. Adverse impacts to future site centers resulting from DNR management activities are difficult to model. Hence, an estimate of incidental take for any given decade is difficult to predict. The degree of impact depends on the productivity of owls in federal reserves and on the location of site centers relative to federal, DNR-managed, and private lands. As habitat on federal reserves approaches conditions which can support a stable population, the number of owls affected by DNR-managed lands is expected to increase (Table 4.3.19). Site centers in federal reserves could be situated such that more than half the owl circle is on federal reserves and less than half on NRF management areas. Other site centers could be situated in NRF management areas with almost half of the circle on federal reserves. In both cases, as federal reserves reach their maximum habitat levels, such site centers would suffer minimal harm from DNR management activities. Other site centers could be situated in NRF management areas such that nearly half of the circle is on private lands. Timber harvest in NRF management areas in such circles would likely result in incidental take.

The response of spotted owls to the landscape conditions which develop in federal, DNR-managed, and private lands will determine the location of site centers. The density of spotted owl habitat to be developed in federal reserves is projected to be greater than that developed in NRF management areas (USDA and USDI 1994a p. 3&4-43). If territorial owls exhibit a preference for higher quality habitat in federal reserves, then the density of site centers in NRF management areas might be highest near federal reserves. As explained above, it is unlikely that these site centers would be taken. It is possible that federal reserves and NRF management areas will become islands of owl nesting habitat. Owls faced with the prospect of dispersing across non-habitat may choose to disperse no further and establish territories near the edge of the island, i.e., NRF management areas. If this were a typical response to landscape conditions, then the density of owls in NRF management areas might be highest near private lands, and many of these site centers may be taken. In short, the number of future site centers that may be taken each decade ranges from zero to the maximum estimated for each decade.

Alternative B results in various levels of projected incidental take, but this alternative should increase the persistence of owl clusters. The Northern Spotted Owl Recovery Team propounded the following biological principle: "Emphasis should be placed on management for clusters, or local population centers, of owls in large habitat blocks rather than for individual pairs" (USDI 1992b p. 57). Extremely small clusters, consisting of one or two site centers, are highly susceptible to local extinction (Diamond 1984 as discussed in USDI 1992b). In contrast, clusters of 15-20 owl pairs are thought to have much higher persistence rates (USDI 1992b). Alternative A is based on the management of individual owl circles. While the amount of incidental take projected under Alternative A is, strictly speaking, zero, site centers will be lost. Alternative A is contrary to the principles of the Northern Spotted Owl Recovery Team (USDI 1992b), and over the long term, it should contribute less and less to the persistence of owl clusters on federal reserves. In the east-side planning units, DNR does not manage a contiguous block of land large enough to support a cluster of 15-20 owl pairs, but Alternative B does augment blocks of federal land which support such clusters.

ALTERNATIVE C

The methods used to analyze Alternative C are the same as those for Alternative B, except that the initial number of owl site centers was 55.

Results. Decline in the number of site centers overlapping NRF management areas could continue for 20-50 years. The number of site centers at year 50 could range from approximately 43 to 70. Based on an average of the five scenarios, the number of site centers overlapping NRF management areas may not return to the current number (73 known and unknown centers) until year 80, and could reach 100 centers by year 100. As discussed below, the number of site centers that may be taken each decade ranges from zero to the maximum estimated for each decade (e.g., 60 in decade four).

Discussion. A calculation of future incidental take based strictly on the USFWS rescinded take-avoidance guidelines produces an ironic outcome. Alternative C provides more nesting habitat than Alternative B. The projections of future owl circles overlapping NRF management areas (Tables 4.3.19 and 4.3.20) show that management activities under Alternative C will affect more site centers than under Alternative B. It is possible, although unlikely, that in any decade the incidental take of site centers could be greater under Alternative C than under Alternative B. Alternative C clearly provides greater benefits to spotted owls, but a comparison of alternatives which uses a strict definition of take can suggest the contrary. This reinforces the difficulty in making accurate projections of incidental take for complex conservation plans.

Alternative C results in various levels of projected incidental take, but this alternative should increase the persistence of owl clusters. Alternative A is based on the management of individual owl circles. While the amount of incidental take projected under Alternative A is, strictly speaking, zero, site centers will be lost. Alternative A is contrary to the principles of the Northern Spotted Owl Recovery Team (USDI 1992b), and over the long term, it should contribute less and less to the persistence of owl clusters on federal reserves. In the east-side planning units, DNR does not manage a contiguous block of land large enough to support a cluster of 15-20 owl pairs, but Alternative C does augment blocks of federal land that support such clusters.

Table 4.3.19: Alternative B: Projections of the number of spotted owl site centers with owl circles overlapping NRF management areas in the east- side planning units

See text for explanation of scenarios. Federal reserves start with of 33 percent of the average landscape in spotted owl habitat. At year 0, λ equals 0.987.

Scenario	λ = 1 at t =	Time (years)									
		10	20	30	40	50	60	70	80	90	100
Interagency Scientific Committee	50 yrs	31	28	26	25	25	25	26	28	31	34
USDI and USDA (1994a) owl habitat >= 120 yr old 60% of landscape	58 yrs	31	28	26	25	24	24	24	25	27	29
USDI and USDA (1994a) owl habitat >= 80 yr old 60% of landscape	32 yrs	31	29	28	28	30	33	36	39	43	48
USDI and USDA (1994a) owl habitat >= 120 yr old 50% of landscape	36 yrs	31	29	28	27	28	30	33	38	46	56
USDI and USDA (1994a) owl habitat >= 80 yr old 50% of landscape	20 yrs	31	30	31	34	40	49	62	78	99	124

Table 4.3.20: Alternative C: Projections of the number of spotted owl site centers with owl circles overlapping NRF management areas in the east- side planning units

See text for explanation of scenarios. Federal reserves start with of 33 percent of the average landscape in spotted owl habitat. At year 0, λ equals 0.987.

Scenario	λ = 1 at t =	Time (years)									
		10	20	30	40	50	60	70	80	90	100
Interagency Scientific Committee	50 yrs	55	50	47	45	44	45	47	50	54	61
USDI and USDA (1994a) owl habitat >= 120 yr old 60% of landscape	58 yrs	55	50	46	44	43	42	43	44	47	51
USDI and USDA (1994a) owl habitat >= 80 yr old 60% of landscape	32 yrs	55	51	50	50	53	58	64	70	77	85
USDI and USDA (1994a) owl habitat >= 120 yr old 50% of landscape	36 yrs	55	51	49	49	50	53	59	68	81	100
USDI and USDA (1994a) owl habitat >= 80 yr old 50% of landscape	20 yrs	55	53	55	60	70	87	110	139	175	220

Criterion 3 -- Amount and Distribution of Owl Dispersal Habitat

The Northern Spotted Owl Recovery Team propounded the following biological principle: "Habitat conditions and spacing between local populations must provide for survival and movement of northern spotted owls" (USDI 1992b p. 58). With this in mind, they described biological goals for nonfederal lands in the Eastern Washington Cascades Province. They listed four areas where connectivity between Designated Conservation Areas (DCAs) was a main concern (USDI 1992b p. 126-128). These areas are:

(1) the checkerboard ownership north from WD-38,[2] extending to the area surrounding and adjacent to WD-33, WD-35, and WD-37;

(2) the checkerboard ownership of the I-90 corridor between WD-38, WD-39, and WD-40;

(3) between the Yakama Indian Reservation and WD-43; and,

[2] WD-38, WD-39, WD-40, etc. are identification numbers for spotted owl Designated Conservation Areas in Washington State.

(4) between the Yakama Indian Reservation and WD-44 and WD-1.

The first area is entirely within the Chelan Planning Unit, the second is entirely within the Yakima Planning Unit, the third is split between the Yakima and Klickitat planning units, and the fourth is entirely within the Klickitat Planning Unit. The Spotted Owl Scientific Advisory Group (Hanson et al. 1993) listed four landscapes in the eastern Washington Cascades where demographic interchange, i.e., dispersal habitat, was considered to be important. These landscapes were:

(1) North Blewett which is within area (1) above;

(2) I-90 east/Teanaway which roughly corresponds to area (2) above;

(3) Easton which is within area (2) above; and,

(4) White Salmon which roughly corresponds to area (4) above.

As is the case for spotted owl nesting habitat, the information in DNR's timber inventory is incompatible with an analysis of owl dispersal habitat. No data items in the inventory correspond to any variables that are typically used to describe spotted owl dispersal habitat, e.g., canopy closure, mean tree diameter, or stand height. Stand age can be used as a reasonable proxy for these habitat variables, but this information is not available for most forest stands on DNR-managed lands in the east-side planning units.

Partial-cutting practices, also known as uneven-aged management, can create dispersal habitat (USDI 1992b). Highly productive sites may develop into suitable dispersal habitat in a relatively short time. The special qualities of east-side conifer forests and their management makes them amenable to the maintenance and development of dispersal habitat. This further confounds the analysis. One consequence of sustainable forestry is that some portion of managed forest lands will function as dispersal habitat, but an estimate of this requires a model that relates the information contained in DNR's timber inventory to the variables describing dispersal habitat. Given the present state of knowledge, the amount of owl dispersal habitat could not be used for a comparison of alternatives. Three variables are comparable among the alternatives -- the certainty associated with (1) the long-term maintenance of dispersal habitat; (2) density of dispersal habitat; and, (3) the geographic location of dispersal habitat.

The management of riparian management zones and unstable hillslopes is the same under all alternatives and so the potential contributions of such management to spotted owl dispersal habitat were ignored in the analysis. There is no mention of the marbled murrelet conservation strategies because they do not extend to the east-side planning units.

ALTERNATIVE A

Under Alternative A, the only dispersal habitat that is certain to remain is that classified as spotted owl nesting habitat situated in owl circles. All nesting or dispersal habitat outside of owl circles may be harvested or degraded to a level at which it no longer functions as dispersal habitat. There are young forests on DNR-managed lands in the east-side planning units that meet the specifications for dispersal habitat, but the USFWS rescinded take-avoidance guidelines do not protect this habitat. The dispersal habitat that would be maintained under this alternative is the 39,600 acres of nesting habitat protected in owl circles (Table 4.3.9).

Thomas et al. (1990) recommended that suitable dispersal habitat cover 50 percent of a landscape measured by quarter township. The density of habitat protected in owl circles and other dispersal habitat created incidentally through regular forest management is unknown. In most contiguous blocks of DNR-managed lands it is probably below 50 percent, and it is unlikely that the density of dispersal habitat will meet the 50 percent recommendation through current silvicultural prescriptions. This is cause for concern in those areas recommended for dispersal habitat by the recovery team.

ALTERNATIVE B

Under this alternative, 85,000 acres will be managed specifically for dispersal habitat (Table 4.3.21; Maps 23, 24, 27). The total of Dispersal management areas and NRF management areas provides 124,100 acres, or 54 percent of DNR-managed lands in the east-side planning units, that should function as dispersal habitat (Table 4.3.22). These areas would be maintained at a 50 percent habitat level measured over watershed administrative units. Nearly all DNR-managed lands in the areas which the recovery team (USDI 1992b) and the Spotted Owl Scientific Advisory Group (Hanson et al. 1993) recommended for dispersal habitat should function as dispersal habitat.

Relative to Alternative A, Alternative B provides greater certainty for the long-term maintenance of dispersal habitat, the density of dispersal habitat, and the geographic location of dispersal habitat.

ALTERNATIVE C

Under this alternative, 55,800 acres will be managed specifically for dispersal habitat (Table 4.3.21; Maps 23, 25, 27). The total of Dispersal management areas and NRF management areas results in 149,700 acres, or 65 percent of DNR-managed lands in the east-side planning units, that should function as dispersal habitat (Table 4.3.22). Dispersal management areas would be maintained at a 50 percent habitat level and NRF management areas at a 60 percent habitat level. Nearly all DNR-managed lands in the areas which the recovery team (USDI 1992b) and the Spotted Owl Scientific Advisory Group (Hanson et al. 1993) recommended for dispersal habitat should function as dispersal habitat.

Alternative C is more beneficial for spotted owls than Alternative B because is provides more dispersal habitat at higher densities over a larger geographic area.

Table 4.3.21: HCP Dispersal Management Areas by planning unit

See Table 4.3.6 for acres of DNR-managed lands in planning units.

	Alternative B			Alternative C		
HCP Planning Unit	Acres Dispersal Management Areas	% DNR-managed land in unit	% of east-side Dispersal Management Areas	Acres Dispersal Management Areas	% DNR-managed land in unit	% of east-side Dispersal Management Areas
Chelan	0	0	0	0	0	0
Yakima	8,300	10	10	8,300	10	15
Klickitat	76,700	58	90	47,500	36	85
Total	85,000	37	100	55,800	24	100

Table 4.3.22: Total area capable of functioning as dispersal habitat for spotted owls

Total equals the sum of Dispersal Management Areas and NRF Management Areas. See Table 4.3.6 for acres of DNR-managed lands in planning units.

	Alternative B			Alternative C		
HCP Planning Unit	Acres serving as dispersal habitat	% DNR-managed land in unit	% of east-side dispersal habitat	Acres serving as dispersal habitat	% DNR-managed land in unit	% of east-side dispersal habitat
Chelan	5,600	36	4	5,600	36	3
Yakima	21,900	27	18	21,900	27	15
Klickitat	96,600	73	78	122,200	92	82
Total	124,100	54	100	149,700	65	100

Criterion 4 -- Demographic Support of Population on Federal Lands

Demographic support refers to the contribution of individual territorial owls to the viability of the entire population. See Section 4.2.1 for discussions of the importance and role of demographic support in the recovery of the spotted owl. The Northern Spotted Owl Recovery Team (USDI 1992b) described biological goals for nonfederal lands in the Eastern Washington Cascades Province. They listed two areas where demographic support of spotted owls in DCAs was a main concern (USDI 1992b p. 126-128). These areas were:

(1) the checkerboard ownership north from WD-38, extending to the area surrounding and adjacent to WD-33, WD-35, and WD-37; and,

(2) the checkerboard ownership of the I-90 corridor between WD-38, WD-39, and WD-40.

The first area is entirely within the Chelan Planning Unit, and second is entirely within the Yakima Planning Unit. The recovery team (USDI 1992b) recommended that nonfederal lands in these areas provide NRF habitat for owls in or directly adjacent to federal reserves. The Spotted Owl Scientific Advisory Group (Hanson et al. 1993) listed five landscapes in the eastern Washington Cascades where demographic support was considered to be important. These landscapes were:

(1) North Blewett which is within area (1) above;

(2) I-90 east/Teanaway which roughly corresponds to area (2) above;

(3) Entiat which is roughly in and around WD-33 and WD-35;

(4) Taneum which is roughly in and around WD-40 and lands south of WD-40 in Kittitas County; and,

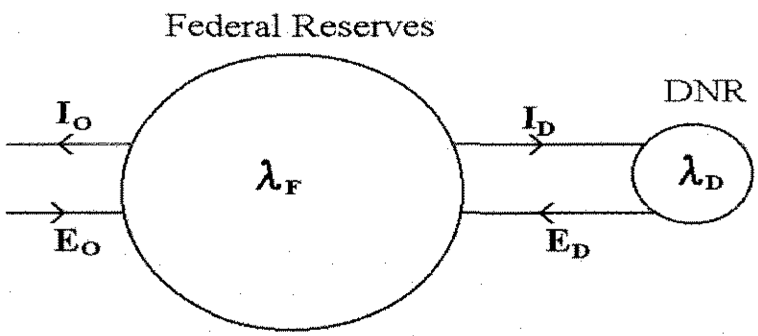
(5) White Salmon which is south of the Yakama Indian Reservation roughly between WD-44 and WD-1.

The direction for nonfederal lands with respect to demographic support is implicit in the biological principles propounded by the Northern Spotted Owl Recovery Team. They stated, "Emphasis should be placed on management for clusters, or local population centers, of owls in large habitat blocks rather than for individual pairs" (USDI 1992b p. 57). Furthermore, it was implied that management should target clusters of 15-20 owl pairs. Clusters of this size or larger are thought to have much higher persistence rates (USDI 1992b). Only one nonfederal land owner, the Yakama Tribe, manages a contiguous block of land large enough to support a cluster of 15-20 owl pairs. The only effective role for other landowners or land managers is the demographic support of clusters on federal reserves.

Methods. The comparison of alternatives relies on a conceptual model of source-sink population dynamics. Across their range, spotted owls occupy habitat that varies in quality. Source sub-populations are those which occupy areas of high quality habitat where natality exceeds mortality (λ greater than 1). Sink sub-populations occupy areas of lower quality habitat were mortality exceeds natality (λ less than 1). For a population in dynamic equilibrium, source sub-populations are net exporters of individuals and sink sub-populations are net importers. Note that the term sink is a misnomer. "Sink" implies a unidirectional flow of individuals -- a drain into which individuals disappear never to return. In theory, sink sub-populations can demographically support source sub-populations, thereby contributing to the stability of the overall population.

A plausible assumption is that the average owl habitat conditions on federal reserves will eventually support a source sub-population of spotted owls, and that the average habitat conditions on DNR-managed lands will support a sink sub-population. The owl habitat on federal reserves supports a sub-population with a finite rate of change, λ_F, greater than one. Habitat on DNR-managed lands supports a sub-population with finite rate of change, λ_D, less than one. The rate of immigration to DNR-managed lands from federal reserves is I_D, and the rate of emigration from DNR-managed lands to federal reserves is E_D. The system is not closed, and so I_O and E_O represent movement of owls between federal lands and other areas. Figure 4.3.1 is a schematic representation of the conceptual model.

Figure 4.3.1: Schematic representation of the conceptual model for demographic support



Three parameters --λ_D, I_D, and E_D -- govern DNR's provision of demographic support. Habitat quality on DNR-managed lands is expressed through λ_D. The comparison of alternatives focuses on a comparison of these three parameters. Owl density on DNR-managed lands is strongly influenced by immigration. Consider, for example, a situation where there is no immigration to DNR-managed lands from federal reserves. If, as assumed, λ_D is less than one, then owls would eventually be extirpated from DNR-managed lands. I_D can be modeled as the product of two rates: the survival rate of dispersing owls and the dispersal rate of owls on federal reserves. Likewise, E_D is the product of the survival rate of dispersing owls and the dispersal rate of owls on DNR-managed lands. Intuitively, the survival rate of dispersing owls is a function of the distance traveled and habitat conditions traversed. The survival probability increases with better habitat, and is inversely related to travel distance. Dispersal rate is more difficult to intuit. A simple, yet useful model posits that dispersal rate is related to the amount of suitable habitat and population density. If there are fewer opportunities to acquire a territory, then a greater proportion of owls will disperse. For a fixed amount of suitable habitat, E_D will increase as λ_D and I_D increase. Finally, E_D is the basic measure of demographic support. If owls do not disperse from DNR-managed lands to federal reserves, then DNR-managed lands would literally be a sink and could not contribute to the viability of the population. In effect, a change in E_D is equivalent to a change in demographic support.

ALTERNATIVE A

Alternative A is based on the management of individual site centers. Whether or not a particular site center is likely to support the source population depends on the proportion of habitat within its owl circle, its distance from federal reserves, and the habitat conditions between it and federal reserves. A consideration of these factors suggests that values for λ_D, I_D, and E_D will be low for many site centers. Other site centers will likely contribute to the source population, but some of these centers exist in clusters of one or two site centers, and thus are highly susceptible to local extinction (Diamond 1984 as discussed in USDI 1992b).

Through compliance with the USFWS rescinded take-avoidance guidelines, DNR would maintain, at least in the short term, a sink sub-population. But, λ_D of the sub-population is expected to be small. Bart (1995) developed an expression which relates the minimum amount of suitable habitat per home range for owl replacement (λ=1) to juvenile survivorship. Burnham et al. (1994) estimated juvenile survivorship to be 0.140 in the Cle Elum study area. Using radio-tracking data, a more accurate estimate of juvenile survivorship which includes emigration can be calculated. Adjusting the Cle Elum juvenile survivorship for emigration (using E = 0.3158 from Burnham et al. 1994) yields a value of 0.205. Using Bart's (1995) equation, λ_D equals 1 if the proportion of suitable habitat per home range is about 60 percent. In the east-side planning units, the mean proportion of habitat in owl circles affected by DNR management is 39 percent, and the proportion of habitat in owl circles is expected to decrease.

While the distance between site centers and federal reserves suggests a potentially high rate of exchange between federal and DNR-managed lands, the habitat conditions to be traversed suggest otherwise. As explained above, the survival rate of dispersing owls should be inversely related to the distance traveled. The vast majority (91 percent) of owl site centers affected by DNR management are within 10 miles of federal reserves (Table 4.3.2), and 13 miles is the median dispersal distance recorded for juvenile spotted owls in the eastern Washington Cascades (n=80; E. Forsman, USDA Forest Service, Corvallis, or unpubl. data 1994). On the other hand, habitat fragmentation would lower the survival rates for owls dispersing to and from site centers. Forty-two percent of owl site centers affected by DNR management are more than 2 miles from federal reserves. The level of support provided by these site centers depends on the survival rates for dispersing owls, and as habitat conditions on DNR-managed and private lands deteriorate, survival rates will decrease. The sink sub-population consisting of owl site centers within 2 miles of federal reserves should have high survival rates for dispersing owls, and is expected to demographically support the source sub-population.

ALTERNATIVE B

In the Chelan and Yakima planning units, DNR establishes NRF management areas in the two areas where the Northern Spotted Owl Recovery Team directed nonfederal lands to provide demographic support. *Additional NRF management areas are established in the* Klickitat Planning Unit. In landscapes considered by the Spotted Owl Scientific Advisory Group to be important for demographic support, DNR-managed lands within 2 miles of federal reserves are designated as NRF management areas.

Alternative B *is expected to decrease the size of the sink sub-population, but this* alternative should increase the parameters that govern the process of demographic support. That is, site centers will be surrounded by better habitat and be closer to federal reserves. At least 50 percent of the DNR-managed lands designated for NRF management would be in NRF habitat at any one time. The NRF habitat would be sub-*mature forest or higher quality habitat as defined* by Hanson et al. (1993). The 50 percent habitat prescription would be applied to watershed administrative units (WAUs). In WAUs where federal reserves are covered by less than 50 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attain a minimum of 50 percent habitat. Given these conservation measures, λ_D of the sink sub-population *supported* by NRF *management areas* should be greater than the λ_D for owls at known site centers where the mean proportion of habitat in owl circles is 39 percent.

Discussion. The average owl habitat density near federal reserves is expected to be greater for Alternative B than for Alternative A (Table 4.3.13). But, since existing old *forest habitat* may be degraded to sub-mature habitat under Alternative B, the short-term habitat quality is expected to be better under Alternative A. Hence, λ_D could be greater for Alternative A. Under Alternative A, natural disturbances and shifting site centers will cause a continual loss of habitat. Much of this lost habitat will be old forest habitat, and, under Alternative A, DNR does not intend to replace this habitat. Therefore, in spite of the degradation of old forest habitat that will occur under Alternative B, over the long term, the conservation measures specified under Alternative B should result in a λ_D that is greater than that of Alternative A. Since NRF management areas are situated within 2 miles of federal reserves, the sink sub-population should have high survival rates for dispersing owls.

ALTERNATIVE C

NRF management areas in the Chelan and Yakima planning units are the same as in Alternative B. More extensive NRF management areas are established in the Klickitat Planning Unit.

Alternative C is expected to increase the size of the sink sub-population, and should increase the parameters that govern the process of demographic support. At least 60 percent of the designated NRF management area would be in NRF habitat at any one time. The NRF habitat would be old forest as defined by Hanson et al. (1993). The 60 percent habitat prescription would be applied to watershed administrative units (WAUs).

In WAUs where federal reserves are covered by less than 60 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attain a minimum of 60 percent habitat. Given these conservation measures, λ_D of the sink sub-population supported by NRF management areas is expected to be greater than that in Alternative B. In fact, calculations using Bart's (1995) equation suggest that λ_D should be close to one.

The sink sub-population consisting of site centers within 2 miles of federal reserves should have high survival rates for dispersing owls. Some NRF management areas in the Klickitat Planning Unit are over 20 miles from federal reserves (Map 25). The survival rates for dispersing owls are expected to be lower for these areas.

Discussion. Alternative C is expected to increase the size of the sink sub-population and increase the demographic support parameters, and therefore, is superior to Alternatives A and B.

Criterion 5 -- Maintenance of Species Distribution

According to the Northern Spotted Owl Recovery Team (USDI 1992b p. 56), "The risk of local or widespread extirpation of northern spotted owls will be reduced by managing for owls throughout their entire range and the variety of ecological conditions within that range." The Spotted Owl Scientific Advisory Group (Hanson et al. 1993) also considered the maintenance of geographic distribution. Of the six eastern Washington landscapes defined by this group, only one, the Entiat landscape, was specifically assigned the conservation function of maintaining the species' geographic distribution. This landscape is entirely within the Chelan Planning Unit.

The assessment of this criterion is confounded by past forest practices, the ecological conditions which these practices have created, and the response of spotted owls to these ecological conditions. Paradoxically, fire suppression in the ponderosa pine zone has likely increased the amount of spotted owl habitat. Forest fire suppression during the past 60-80 years has altered the natural patterns of community succession (Franklin and Dyrness 1973; FEMAT 1993). This is particularly true for ponderosa pine forests which are fire-maintained subclimax communities. Mature stands of ponderosa pine are typically more open and less structurally complex than stereotypic owl nesting habitat. Frequent low-intensity wildfires have a return interval of 8-12 years in unmanaged ponderosa pine stands (Franklin and Dyrness 1973). These fires limit the degree of canopy closure, retard the development of multi-layered canopies, and consume down dead woody debris -- all important components of owl habitat (USDI 1992b). It is possible that fire suppression has extended the range of the spotted owl eastward into the ponderosa pine zone, or at least increased the density of spotted owls nesting there. Most of the Klickitat Planning Unit south of the Yakama Indian Reservation is within the ponderosa pine zone (Franklin and Dyrness 1973).

There are three dimensions to species geographic range -- latitude, longitude, and elevation. Vegetational zones are strongly correlated with latitude, longitude, and elevation. Hence, it is assumed that an assessment of geographical range will adequately account for the variety of ecological conditions within that range. In the eastern Washington Cascades, elevation is correlated with longitude, so longitude is assumed to be an adequate surrogate for elevation. Federal reserves maintain the entire latitudinal range of the spotted owl across Washington and Oregon, so the criterion reduces to an assessment of longitudinal range. Notably, while the longitudinal range of spotted owls on the west side (i.e., from the Cascade crest to the Pacific coast) varies from 120-160 miles, their longitudinal range on the east side (i.e., from the Cascade crest to the shrub-steppe zone) is only 20-50 miles. Hence, on the east side, changes in geographic range on the order of miles could have consequences for population viability.

In the Chelan Planning Unit, federal reserves cover much of the longitudinal range (Map 27), and federal matrix lands, if managed properly, have the potential to maintain the entire longitudinal and elevational range of the spotted owl. Therefore, the potential contribution of DNR-managed lands to the maintenance of geographic range in the Chelan Planning Unit is insignificant. DNR-managed lands in the Yakima Planning Unit (Map 23), in particular those in Township 20 N, Ranges 19-20 E, have the potential to make a contribution to the maintenance of species range. However, the most eastern portions of this area are in the ponderosa pine zone (Franklin and Dyrness 1973). Other opportunities to maintain the eastern limit of the owls distribution exist in the Yakima Planning Unit, namely the checkerboard ownership in Township 15 N, Ranges 15-17 E and Township 18 N, Ranges 16-17 E. The value of these contributions is dependent on WDFW, the other major land manager in these townships.

The Yakama Indian Reservation is the major landowner in the Klickitat Planning Unit and manages approximately 250,000 acres of spotted owl habitat (USDA and USDI 1994a p. D-4). Continuation of current management practices on the reservation will make a valuable contribution to the maintenance of the species' range. Since only a small portion of federal land in the planning unit has a reserve status, a gap exists in the expected long-term distribution of owl habitat. Large blocks of DNR-managed lands in the western portion of the Klickitat Planning Unit have the potential to fill this gap. DNR manages scattered legal sections and irregular parcels throughout the central and eastern portion of the planning unit. They are widely distributed and isolated, and it is unlikely that DNR management alone could maintain the current species range. Furthermore, these sections and parcels are in the ponderosa pine zone.

ALTERNATIVE A

Under Alternative A, DNR continues its policy of take-avoidance. All owl habitat outside of spotted owl circles will eventually be harvested. Management for spotted owls will continue on a circle-by-circle basis. No new habitat would be allowed to develop in circles that are below the 40 percent minimum, and any habitat lost to natural or human-caused disturbance would not be replaced. The geographical shift of an owl site center alters the location of its owl circle, and this may release owl habitat for harvest. DNR's contribution to the maintenance of species range consists of owl habitat protected in owl circles.

In the Yakima Planning Unit, the most easterly owl site centers (status 1, 2, or 3) are located in Township 20 N, Range 21 E, section 2; Township 20 N, Range 19 E, section 27; Township 20 N, Range 18 E, section 30; and Township 21 N, Range 19 E, section 25. All of these circles contain DNR-managed lands. The site center in Township 20 N, Range 21 E is located on the eastern boundary of the spotted owl's current geographic range. The owl circle associated with this center contains less than 20 percent habitat, and so is unlikely to support territorial owls or contribute to the maintenance of the species' range. The other three site centers have owl circles that extend 1-4 miles east of federal reserves, but are 10-12 miles west of the eastern boundary of the owl's geographic range. The proportion of these circles that is owl habitat is less than 40 percent. The long-term persistence of these site centers is questionable.

In the Klickitat Planning Unit south of the Yakama Indian Reservation, six known site centers (status 1, 2, or 3) exist east of Range 12 E. The site center in Township 6 N, Range 15 E, section 2 is located the farthest east. The owl circle associated with this center contains less than 20 percent habitat, and so is unlikely to support territorial owls or contribute to the maintenance of the species range. Under Alternative A, a cluster of four site centers in Townships 5-6 N, Range 13 E would be DNR's contribution toward the maintenance of the species' current range in the Klickitat Planning Unit. Three of the four site centers have owl circles with greater than 40 percent habitat and should be capable of supporting territorial spotted owls. These owl circles extend 21-25 miles east of federal reserves, but are 20-25 miles west of the eastern boundary of the owl's geographic range.

ALTERNATIVE B

In the Yakima Planning Unit (Map 23), NRF management areas extend 2 miles east of federal reserves, but this is 12 miles west of the eastern boundary of the owl's geographic range. In the Klickitat Planning Unit (Map 24), NRF management areas extend 2 miles east of federal reserves, but this is about 42 miles west of the eastern boundary of the owl's geographic range. Under Alternative B, this constitutes DNR's contribution toward the maintenance of the species' current range in this planning unit.

Discussion. The short-term reduction of the owl's current range is greater under Alternative B than under Alternative A. On the other hand, the long-term certainty associated with the maintenance of geographic range is greater for Alternative B. A key assumption used for the analysis of Alternative A could be invalidated by changes in agency policy. DNR could conduct protocol surveys to decertify existing owl circles. Any owl habitat on DNR-managed lands within decertified owl circles would be available for harvest. Also, it is worth reiterating that under Alternative A, any habitat lost to natural or human-caused disturbance would not be replaced, and that geographical shifts of a site center may release owl habitat for harvest. It seems inevitable that site centers in the far eastern parts of the owl's geographic range will have insufficient habitat to support territorial owls.

There is a trade-off between Alternatives A and B. Alternative A offers to maintain owls over a greater portion of the species' current geographic range, but only over the short term. On the other hand, Alternative B offers to maintain owls over a lesser portion of the species' current geographic range, but with long-term certainty. Neither alternative maintains the current range over the long term, so the pivotal question is this: does the survival and recovery of the spotted owl depend on the short-term maintenance of its geographic range in the eastern Washington Cascades? There are no data available with which to predict the population level effects of range reduction, but the Northern Spotted

Owl Recovery Team's rationale for the maintenance of the species' range forms a basis for comparison.

The Northern Spotted Owl Recovery Team (USDI 1992b) believed that the risk of extinction would be reduced by managing for owls throughout their entire range. They stated four primary reasons for the importance of maintaining the full range of the species. First, the viability of the entire population is directly related to the number of owl clusters. Under Alternative B, the cluster of four site centers in Townships 5-6 N, Range 13 E would suffer immediate adverse impacts, but under Alternative A this same cluster might be maintained for decades. Second, a reduction in geographic range would reduce the range of ecological conditions occupied by owls, thereby making the species more vulnerable to environmental changes such as drought, harsh winters, etc. Under Alternative B, site centers in drier climates would be lost, but under Alternative A they may be maintained over the short term. Third, range reduction would affect the evolution of the species. Habitat conditions are usually extreme on the fringes of a species' geographic range and extreme conditions are often the impetus for rapid adaptation. Again, under Alternative B, site centers in extreme habitat conditions, i.e., the ponderosa pine zone, would be lost. The evolutionary significance of adaptation to the artificial ecological conditions existing in the ponderosa pine zone is unknown. Fourth, if global climate change occurs, then range reduction could have significant consequences. For example, under some global warming scenarios local cooling points appear. If the climate cooled in portions of the owls range, then southerly portions of the range might be more important. Under Alternative B, the eastern extent of the owl's range in southern Washington would be appreciably reduced.

The third and fourth reasons address long-term risks to the population. These risks are present under both Alternatives A and B, and so provide no basis for comparison. The first and second reasons address short-term risks. Both Alternatives A and B are expected to narrow the spatial distribution of owl habitat in the eastern Washington Cascades. But, since the amount of owl habitat would be reduced more rapidly under Alternative B, it appears that the short-term risk to the population is greater under Alternative B.

ALTERNATIVE C

In the Yakima Planning Unit, NRF management areas are the same as in Alternative B. They extend 2 miles east of federal reserves, but this is 12 miles west of the eastern boundary of the owl's geographic range. In the Klickitat Planning Unit (Map 25), NRF management areas extend approximately 30 miles east of federal reserves. This is about 12 miles west of the eastern boundary of the owl's geographic range. Since Alternative C guarantees the maintenance of owl habitat over the widest part of the owl's current geographical range, it is clearly superior to Alternatives A and B for this criterion.

Criterion 6 -- Forest Health and Risk of Catastrophic Disturbance

Historically, wildfire has played a central role in the landscape dynamics of the eastern Washington Cascades. This is particularly true for ponderosa pine forests which are fire-maintained subclimax communities. Forest fire suppression during the past 60-80 years has altered the natural patterns of community succession (Franklin and Dyrness 1973;

FEMAT 1993) and made forests more susceptible to wildfire, insect attacks, disease, and windthrow (FEMAT 1993; Agee and Edmonds 1992). The development of multi-layered stands containing Douglas-fir and true fir results in conditions favorable to insect defoliators -- in particular, Douglas-fir tussock moth and western spruce budworm (Agee and Edmonds 1992). Fire suppression promotes epidemics of foliage diseases, root rots, heart rots, and dwarf mistletoes (Agee and Edmonds 1992). Trees infected by root rots have a higher likelihood of windthrow.

In the eastern Washington Cascades, one of the most severe threats to the continued existence of spotted owls is thought to be natural disturbance (USDI 1992b). Fire suppression in some areas has greatly increased the probability of large-scale stand-replacement fires (USDI 1992b). Agee and Edmonds (1992) concluded that there is a very low probability that federal reserves in the east Cascades subregion will avoid catastrophic wildfires during the next century. The same could be said for many DNR-managed forests classified as spotted owl habitat. The Northern Spotted Owl Recovery Team believed that active management was necessary to reduce the risk of catastrophic natural disturbance (USDI 1992b p. 183-184). Their recommended management strategies would protect owl habitat by degrading owl habitat. For example, to reduce risks from fire a fuel break system and controlled underburning were recommended. Also, thinning of stands was recommended to reduce risks due to insect infestations.

Title 76 and Title 79 of the Revised Code of Washington (RCW) contain regulations pertinent to forest health issues. DNR is directed to sell any timber damaged by fire, wind, or any other cause, as fast as possible when selling that timber is in the best interest of the trusts (RCW 79.01.790 and RCW 79.01.795). RCW 76.04.660 specifies that landowners responsible for the existence of extreme fire hazard are "...required to abate, isolate and reduce the hazard." In addition, Policy No. 10 of the Forest Resource Plan (DNR 1992b) directs the department to take preventive measures beyond what is required by law. Prescribed underburns, precommercial thinning, and commercial thinning may be used to reduce fire hazard. Currently, about 500 acres of DNR-managed lands are underburned per year, but approximately 2,000 acres per year might benefit from underburning.

Under RCW 76.06.040, owners of timberlands "...shall make every reasonable effort to control, destroy, and eradicate..." forest insect pests and forest tree diseases which threaten the existence of any stand of timber. In addition, Policy No. 9 of the Forest Resource Plan (DNR 1992b) directs the department to adopt practices that maintain the health of DNR-managed forests. The application of pesticides is an effective method for the control of forest insect pests. The level of pesticide application is extremely difficult to predict due to natural variation in pest population cycles. However, one can reasonably assume that at least 2,000 acres of DNR-managed lands per decade may be treated with pesticides (DNR 1996a p. IV-185).

Alternative A

Under Alternative A, DNR would continue to comply with the USFWS rescinded take-avoidance guidelines (USDI 1990). All owl habitat outside of spotted owl circles will eventually be harvested. No new habitat would be allowed to develop in circles that are below the 40 percent minimum, and any habitat lost to natural or human-caused disturbance would not be replaced.

DNR's take-avoidance policy might prohibit full compliance with Titles 76 and 79 RCW or conflict with Board policies which address fire hazard and forest health. In some cases, management activities within an owl circle conducted to reduce extreme fire hazard or control insect damage could be construed as incidental take. Failure to conduct such activities could increase the risk of owl habitat loss through localized or catastrophic disturbance.

ALTERNATIVE B

Under Alternative B, approximately 39,200 acres would be managed for spotted owl nesting, roosting, and foraging habitat (Table 4.3.10; Maps 23, 24, 27). At least 50 percent of the DNR-managed lands designated as NRF management areas would be in NRF habitat at any one time. The 50 percent habitat prescription would be applied to watershed administrative units (WAUs). In WAUs where federal reserves are covered by less than 50 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attained a minimum of 50 percent habitat. In WAUs where natural or human-caused disturbance reduces habitat below the 50 percent minimum, habitat would be redeveloped.

Forest conditions may warrant DNR's compliance with Titles 76 and 79 RCW. When DNR determines that management activities required by the HCP are inconsistent with Titles 76 and 79, consultation will be held with the USFWS regarding possible amendments to the HCP. If USFWS determines that such activities would adversely affect spotted owls, then DNR and USFWS would work to identify mitigation.

Discussion. For the previous five evaluation criteria, certainty has been a factor in the comparison of alternatives. For the sixth criterion, certainty is central to the comparison. Forest conditions in the eastern Washington Cascades have lead to the conclusion that the destruction of owl habitat through wildfire has a very high probability. Alternative B combats the near certainty of wildfire with the certainty that owl habitat will be restored. Furthermore, this alternative may provide more flexibility to conduct forest practices for the purpose of hazard reduction.

The risk to spotted owl habitat from natural disturbance may put the benefits of Alternative B in perspective. The eastern Cascades are prone to wildfires, and spotted owl nesting habitat possesses the ideal structural characteristics for large stand-replacing fires -- a multi-layered canopy and plentiful down woody debris. The frequency of occurrence for large stand-replacing fires in the eastern Cascades is about 10-20 years. Over 100 years, the proposed term of the HCP, the number of such fires could range from 5-10 events. Recent wildfire history in the eastern Washington Cascades illustrates the risk to owl habitat in the coming decades: in 1988 the Dinkleman fire (Chelan County) covered 50,000 acres; in 1992 the Skookum fire (Klickitat County) covered 51,000 acres; and, in 1994, the Tyee and Hatchery fires (Chelan County) covered 135,000 and 43,000 acres, respectively (DNR and Washington Department of Community, Trade and Economic Development 1994; DNR 1994b). Not all acres burned were owl habitat, and not all owl habitat that burned was destroyed. Nevertheless, the total acreage burned in less than one decade in the eastern Washington Cascades (279,000 acres) is four times the amount of owl habitat currently under DNR management. If the amount of owl habitat consumed by wildfire on DNR-managed lands were to average 4,000 acres/decade, then over 100 years all the habitat protected under Alternative A (Table 4.3.13) would be lost. Furthermore, any habitat remaining under Alternative A would likely be highly fragmented and of little value to territorial owls. While the likelihood of habitat loss remains high under Alternative B, these alternatives offer the certainty that lost habitat will be restored.

ALTERNATIVE C

Under Alternative C, approximately 93,900 acres would be managed for spotted owl nesting, roosting, and foraging habitat (Table 4.3.10; Maps 23, 25, 27). In the Chelan and Yakima planning units, the area designated for NRF management areas is the same as Alternative B, but is substantially larger in the Klickitat Planning Unit. At least 60 percent of the designated NRF management area would be in NRF habitat at any one time. The 60 percent habitat prescription would be applied to watershed administrative units (WAUs). In WAUs where federal reserves are covered by less than 60 percent owl habitat, all DNR-managed owl habitat would be retained until the federal reserves attained a minimum of 60 percent habitat. In WAUs where natural or human-caused disturbance reduces habitat below the 60 percent minimum, habitat would be redeveloped.

Forest conditions may warrant DNR's compliance with Titles 76 and 79 RCW. When DNR determines that management activities required by the HCP are inconsistent with Titles 76 and 79, consultation will be held with the USFWS regarding possible amendments to the HCP. If USFWS determines that such activities would adversely affect spotted owls, then DNR and USFWS would work to identify mitigation.

Discussion. Alternative C combats the near certainty of wildfire with the certainty that owl habitat will be restored. Furthermore, this alternative may provide more flexibility than Alternative A to conduct forest practices for the purpose of hazard reduction. Alternative C guarantees the restoration of owl habitat following catastrophic disturbance over a much larger area than Alternative B.

Summary Comparison of Alternatives

Alternative C is expected to enhance the survival and recovery of spotted owls in the Eastern Washington Cascades Province. For all six evaluation criteria, Alternative C results in either the greatest net benefit or the least adverse impact to the owl population. Alternative C provides the largest amount of NRF and dispersal habitat (Table 4.3.23). Owl habitat will be the least fragmented, have the widest geographic distribution, and be maintained with a high level of certainty. Also, under Alternative C, the fewest site centers suffer adverse impacts.

The comparison of Alternatives A and B can be reduced to an assessment of short-term risk versus long-term risk. Alternative B poses greater short-term risk to the spotted owl population in the Eastern Washington Cascades Province, but Alternative A poses greater long-term risk. Over the short term, Alternative B harvests more owl habitat and puts more site centers at risk for take (Table 4.3.23). Alternative A is likely to maintain a larger proportion of existing owl habitat and site centers over the short term, but over the long term natural disturbance and shifting site centers are likely to cause a substantial reduction in both habitat and occupied site centers. An important element in comparing the long-term risk of the alternatives is certainty. Alternative B is projected to remove more habitat, but the amount and spatial distribution of the remaining habitat, and habitat to be developed, are known and the product of a conservation plan. It is likely that under Alternative A, owl habitat on DNR-managed lands will become more fragmented and less capable of supporting spotted owls. Furthermore, under Alternative A, low confidence must be assigned to any estimate of future owl habitat conditions on DNR-managed lands. This is particularly true in the eastern Washington Cascades where fire suppression has greatly increased the probability of catastrophic disturbance.

Our assessment leads to us to conclude that the long-term risk of extinction is less under Alternative B. Is this long-term benefit worth the short-term risk? In other words, will the short-term risks appreciably reduce the likelihood of survival and recovery of the species? The President's Forest Plan included an assessment of the likelihood that the plan would support species' populations (FEMAT 1993). Panelists assessing the spotted owl population assigned an 83 percent likelihood to outcome A (FEMAT 1993 p. IV-153) -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, well-distributed across federal lands. The remaining 18 percent was assigned to outcome B -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, but with significant gaps in the historic species distribution on federal land. In effect, the panelists concluded that the risk of spotted owl extinction under the President's Forest Plan is zero. In an independent assessment, USFWS stated that the President's Forest Plan "...should provide a strong habitat network to maintain a viable and self-sustaining population of spotted owls for the next 100 years" (USDA and USDI 1994a p. G-18). If the President's Forest Plan is successfully implemented, then the short-term risk to the species is minimal. Placed in this context, the long-term benefits of Alternative B are worth the short-term risk.

Alternative B follows the principles propounded by the Northern Spotted Owl Recovery Team. They stated, "Emphasis should be placed on management for clusters, or local population centers, of owls in large habitat blocks rather than for individual pairs" (USDI 1992b p. 57). Alternative B concentrates owl habitat in proximity to federal reserves, and is thus more likely to support spotted owls clusters on federal reserves. Again, under Alternative A, owl habitat on DNR-managed lands is expected to become more fragmented, i.e., less concentrated, and the spatial arrangement of habitat will be astrategic. In short, Alternative B provides better conservation for spotted owls in the eastern Washington Cascades than Alternative A.

Table 4.3.23: Summary of alternatives for all criteria

Criterion		Alternative A	Alternative B	Alternative C
NRF Amount Habitat	Amount	44,400 acres -34 percent change low long-term certainty	19,600 acres -71 percent change high long-term certainty	56,300 acres -16 percent change high long-term certainty
	Distribution	widely distributed high fragmentation	narrowly distributed low fragmentation	widely distributed low fragmentation
Impact to Current Site Centers	Current	unlikely to persist 27 may not persist 15	incidental take 29 potential take 18	incidental take 9 potential take 24
	Future	not analyzed	difficult to accurately predict, depends on federal reserves	difficult to accurately predict, depends on federal reserves
Dispersal Amount Habitat	Amount	44,400+ acres low long-term certainty	62,100 acres high long-term certainty	84,200 acres high long-term certainty
	Distribution	randomly distributed high fragmentation	strategically distributed low fragmentation	strategically distributed low fragmentation
Demographic Population Support	Population	decrease in sink population	decrease in sink population	increase in sink population
	Process	decrease in parameters governing process	increase in parameters governing process	increase in parameters governing process
Maintenance of Range	short-term	moderate reduction	large reduction	small reduction
	long-term	large reduction	large reduction	small reduction
Catastrophic Disturbance		high risk of habitat loss no habitat replacement	high risk of habitat loss guaranteed habitat replacement	high risk of habitat loss guaranteed habitat replacement

Cumulative Effects

The purpose of this section is to discuss the alternatives in the context of other significant actions affecting spotted owls in the eastern Washington Cascades. These actions are the President's Forest Plan and the proposed 4(d) special rule for the northern spotted owl.

The President's Forest Plan

A description of owl habitat on federal lands and the President's Forest Plan appears near the beginning of Section 4.3.1.

The President's Forest Plan includes an assessment of the likelihood that the plan would support species' populations (FEMAT 1993). Panelists assessing the spotted owl population assigned an 83 percent likelihood to outcome A (FEMAT 1993 p. IV-153) -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, well-distributed across federal lands. The remaining 18 percent was assigned to outcome B -- habitat under the plan is of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, but with significant gaps in the historic species distribution on federal land. In effect, the panelists concluded that the risk of spotted owl extinction under the President's Forest Plan is zero.

The single most important action affecting northern spotted owls is the President's Forest Plan, but as of February 1996, the plan's implementation was not proceeding as was originally anticipated. Spotted owl habitat slated for protection under the plan has been authorized for harvest under an emergency 2-year salvage timber sale program (Pub. L. No. 104-19, 109 Stat. 240 (1995)). How future political decisions might alter the President's Forest Plan and the management of owl habitat on federal lands remains to be seen. Further weakening of the plan could invalidate the species assessments performed by the FEMAT panelists.

The key assumption underlying DNR's HCP alternatives is the validity of the FEMAT species assessments. Given that the President's Forest Plan is likely to result in owl habitat of sufficient quality, quantity, distribution, and abundance to allow the species population to stabilize, well-distributed across federal lands, DNR's contributions to the survival and recovery of the species are most appropriately demographic support and facilitation of dispersal. The FEMAT assessments were contingent on the successful implementation of the President's Forest Plan. But, if owl habitat conditions on federal lands are substantially inferior to that originally projected for the President's Forest Plan, then owl habitat on DNR-managed lands will become more important to the survival and recovery of the species.

The President's Forest Plan recognized that in "...areas of special concern, contributions of nonfederal lands remain important to recovery of the species" (USDA and USDI 1994a p. 3&4-245). "Special areas" include areas where private, state, and federal lands are intermingled, or where federal lands are absent. The designation of these special areas was left to a final recovery plan or to a proposed 4(d) special rule for the northern spotted owl.

Proposed (4)d Special Rule

The "proposed 4(d) special rule" refers to section 4(d) of the Endangered Species Act. Pursuant to section 4(d), special rules may be promulgated with respect to a particular federally listed species. Such special rules may permit incidental take so long as they meet the conservation needs of the listed species. USFWS recognizes the significant contribution the plan makes toward spotted owl conservation, and proposes to lift the blanket prohibition against incidental take (60 Fed. Reg. 9484 (1995)). On the other hand, USFWS believes that supplemental support from nonfederal lands is necessary, hence certain restrictions would remain in effect. Three stipulations of the proposed 4(d) special rule are particularly relevant to the assessment of alternatives. First, the rule establishes six Special Emphasis Areas (SEAs) where the USFWS rescinded take-avoidance guidelines would be retained (60 Fed. Reg. 9484 (1995)). Second, outside of SEAs the take-avoidance guideline would be relaxed to the 70 acres of NRF habitat closest to the site center (60 Fed. Reg. 9484 (1995)). Third, all landowners still retain the opportunity to seek regulatory relief through an approved HCP.

Two SEAs are in the east-side planning units -- the I-90 corridor and the Columbia River Gorge/White Salmon. A small portion of the I-90 corridor SEA lies in the Chelan Planning Unit and a much larger portion lies in the Yakima Planning Unit. DNR-managed lands in the I-90 corridor SEA consist of scattered legal sections and smaller parcels. The final boundaries of the SEAs have yet to be defined, but it is anticipated that the total amount of east-side DNR-managed lands in the I-90 corridor SEA will be approximately 8,700 acres, or less than 2 percent of this SEA east of the Cascade crest. The White Salmon portion of the Columbia River Gorge/White Salmon SEA lies in the Klickitat Planning Unit. It includes a large contiguous block of DNR-managed lands in Townships 4-5 N, Range 10 E, and scattered sections and smaller parcels east of Range 10 E. It is anticipated that the total amount of east-side DNR-managed lands in the White Salmon portion will be approximately 40,000 acres, or about 30 percent of this portion of the SEA.

ALTERNATIVE A

DNR continues its policy of take-avoidance and complies with the take-avoidance guidelines of the proposed 4(d) special rule. In SEAs, management for spotted owls continues on a circle-by-circle basis. One presumption is that the proposed 4(d) special rule for the spotted owl will meet the conservation needs of the species, and therefore there should be no significant cumulative effects for this alternative. In fact, USFWS in assessing the conservation needs of the spotted owl was mindful of the "...emerging non-Federal landowner habitat management and owl conservation strategies such as Habitat Conservation Plans" (60 Fed. Reg. 9484 (1995)). By land area covered, DNR's HCP is the largest in the range of the northern spotted owl. If Alternative A were to be adopted, then the assessment conducted for the proposed 4(d) special rule could be invalid.

Alternative B

In the I-90 corridor SEA, 85 percent of east-side DNR-managed lands is designated for NRF or dispersal management areas. Given that less than 2 percent of the I-90 corridor SEA east of the Cascade crest is DNR-managed lands, it is unlikely that the cumulative effects of Alternative B would be significant in this SEA. DNR-managed lands comprise nearly one-third of the White Salmon portion of the Columbia River Gorge/White

Salmon SEA. Seventy-six percent of DNR-managed lands are designated for Dispersal management areas, but only 16 percent is designated for NRF management areas. One function of this SEA is the demographic support of owls on federal reserves (60 Fed. Reg. 9484 (1995)). The cumulative effects of Alternative B may significantly limit the capacity of this SEA to perform its intended functions.

ALTERNATIVE C

Alternative C is the same as Alternative B in the I-90 corridor SEA. In the Klickitat Planning Unit, nearly all DNR-managed lands in the White Salmon portion of the Columbia River Gorge/White Salmon SEA are designated for NRF habitat management areas. The cumulative effects of Alternative C should enhance the capacity of this SEA to demographically support owls on federal reserves.

OTHER SPOTTED OWL HCPS

One other HCP in the east-side planning units is nearing completion. The Plum Creek Timber Company has developed an HCP for 167,200 acres of its land in the checkerboard ownership of the I-90 corridor (Plum Creek Timber Company 1995). Plum Creek defined its own HCP planning area which encompasses 418,700 acres. The planning area includes less than 4,000 acres of east-side DNR-managed lands. The DNR-managed lands consists of scattered legal sections and smaller parcels. All east-side DNR-managed lands within the Plum Creek HCP planning area is designated for NRF or dispersal habitat management. Forty-eight percent of the Plum Creek HCP planning area is federal ownership. The HCP developed by Plum Creek utilizes to its maximum advantage the spotted owl habitat on federal land. The important long-term commitments of this HCP for spotted owl conservation include: (1) at a minimum, 8 percent of Plum Creek ownership will be maintained in spotted owl NRF habitat; (2) development of dispersal corridors for high density owl cluster areas; and (3) provision of NRF and dispersal habitat between and within spotted owl DCAs in the planning area in support of the biological goals outlined in the Final Draft Plan for the Northern Spotted Owl.

Considering the small amount of DNR-managed lands in the Plum Creek Timber Company HCP planning area, all DNR alternatives should have an insignificant cumulative effect on spotted owls present there now or in the future. As of February 1996, the Plum Creek HCP was officially incomplete. This assessment of cumulative effects may change following its completion.

4.3.2 Riparian Habitat

There are no proposals to alter current management of riparian or aquatic ecosystems east of the Cascade crest. Currently, management is guided by the Washington Forest Practices Rules (WFPB 1995c) and DNR's Forest Resource Plan (1992). DNR manages for no overall net loss of naturally occurring wetland acreage and function (Forest Resource Plan Policy No. 21). Riparian management zones are established on all Type 1, 2, 3, and 4 Waters and, when necessary, along Type 5 Waters (Forest Resource Plan Policy No. 20). No harvest would occur on hillslopes identified in the field as having a high potential for mass wasting. The potential impacts of the Forest Resource Plan were addressed in the accompanying EIS (1992a); in particular, see the Aquatic Systems Policy (p. 76-83), Existing Environmental Conditions (p. 150-157), and Significant Environmental Impacts (p. 198-200, 208-209).

Implementation of the northern spotted owl strategy under Alternative B or Alternative C, however, would alter the spatial distribution and management of late-successional forests, and this could affect riparian and aquatic ecosystems. A large proportion of such forests are currently unavailable for harvest due to spotted owls and the USFWS guidelines for their protection. All alternatives are projected to result in a reduction of late-successional forest. Over the short-term, Alternative B results in the greatest reduction of late-successional forest on DNR-managed lands (74 percent), followed by Alternative C (38 percent) and Alternative A (34 percent). The most significant impacts of these reductions would occur along some Type 5 Waters which currently receive some incidental protection through the spotted owl guidelines which prohibit timber harvest in some areas. Also, under the action alternatives, there could be an increase in cumulative adverse impacts to water quality and quantity because of increased management activity in certain watersheds. However, since, under all alternatives, management must be consistent with the Forest Resource Plan, there should be no significant differences in the impacts to riparian and aquatic ecosystems.

4.4 Olympic Experimental State Forest Planning Area

4.4.1 Experimental Nature of Integrating Conservation and Production in the OESF

Chapter 1, Section 5 of the DEIS provides an overview of the Olympic Experimental State Forest. Chapter 1 of the draft Habitat Conservation Plan explains why the OESF is a unique planning unit. However, it is worth repeating here that the basic assumption underlying the OESF is that rigorously designed experimentation and the application of non-traditional forest practices in a commercial forest will provide improved solutions to forest management problems.

Experimentation and risk

This experimental aspect of the conservation strategies and the management approach to the OESF is an integral part of the multispecies habitat conservation proposal. Experimentation is not fully predictable and individual projects will require balancing assessments of potential risks against the potential benefits of new knowledge that may be gained.

Research Activities

The draft EIS and proposed draft HCP describe the research and monitoring that ensure compliance with the HCP and form a basis for the incidental take permit. A broader range of research and monitoring will be needed to achieve the goals of the OESF than what is described in the proposed draft HCP. These research and monitoring activities, some of which are already being conducted, are covered by the current Forest Resource Plan (1992) and do not relate directly to the HCP conservation strategies for federally listed species. Silvicultural techniques and harvest technology research are two examples. The policies for this research received public review through the SEPA process prior to the Forest Resource Plan's adoption.

Currently, research in the OESF that alters the forest is only conducted outside areas considered habitat for listed species. Under the HCP, such research activities would occur in areas of the OESF Planning Unit that are considered habitat for listed species. The ability to conduct management and research activities in these areas is one of the stated purposes for DNR's proposed action. These activities are an integral part of the proposed conservation strategies, and potential environmental consequences are evaluated in this draft EIS for the HCP under the associated resources.

In addition to research and monitoring related to conservation in the OESF, DNR will explore new technologies and systems for achieving harvest or silvicultural treatments and techniques for integrating production and conservation in ways as yet unrealized. Some, but not all, of this research and monitoring will be associated with timber sales. Currently, all timber sales, including experimental designs, techniques, etc., undergo environmental review in compliance with SEPA. The action alternatives (Alternatives 2 and 3) do not propose to alter the current methods by which DNR complies with state law. Research and monitoring not associated with timber sales will receive similar SEPA attention. Should an individual research project constitute a non-exempt unique action, it will be reviewed in compliance with SEPA.

When the OESF research and monitoring program is more fully developed, the assumption that it is fully covered by the Forest Resource Plan and the HCP environmental reviews will be revisited to determine whether or not additional environmental review is required. However, at this time, no activities are anticipated that would fall outside these two reviews.

Matrix 4.4.1: Management strategies for alternatives related to the OESF planning unit

	Alternative 1 No Action	Alternative 2 Unzoned Forest Preferred OESF	Alternative 3 Zoned Forest
Research and Monitoring			
Research and Monitoring	Current level of research activities consistent with FRP Policy No. 40 without special emphasis in OESF. No concentrated effort to integrate commodity production with conservation or to integrate other unique aspects of the OESF.	Initiate innovative program of experimental management, research, and habitat restoration activities throughout 11 landscape units. Initiate clearly defined, structured decision-making process for adapting management in response to new, validated information.	Inititate experimental management, research, and restoration activities across majority of DNR-managed lands in OESF. Conduct limited research activities within: (a) zones designated to support clusters of spotted owl pairs; (b) in riparian and marbled murrelet habitat; and, (c) second-growth stands outside owl zones. The full extent of this research has not been defined; program is assumed to be less than Alternative 2 due to lower expected revenues. Initiate clearly defined, structured decision-making process for adapting management in response to new, validated information.

4.4.2 Analysis of the Riparian Conservation Strategy for the Olympic Experimental State Forest

4.4.2 Analysis of the Riparian Conservation Strategy for the Olympic Experimental State Forest

4.4.2.1 Summary

This chapter section evaluates the environmental consequences of current and proposed strategies for managing and conserving riparian and aquatic systems in the Olympic Experimental State Forest (OESF). Section 4.4.2.2 describes current conditions of riparian processes and functions in the OESF, as well as present management practices affecting those processes and functions. Section 4.4.2.3 discusses the abilities of the No Action alternative (OESF Alternative 1) and two proposed action alternatives (OESF Alternatives 2 and 3) to protect and aid natural restoration of key riparian parameters.

Management strategies for conserving riparian processes and functions under Alternatives 1, 2, and 3 are summarized in Matrix 4.4.2a. The No Action alternative comprises both current management practices and those strategies expected to be in place once the Washington Department of Natural Resources (DNR) Forest Resource Plan (1992) is implemented fully. Presently, DNR policies directly related to riparian and aquatic management have been implemented only partially, and explicit guidelines for strategy implementation do not exist for most policies. The objective of the proposed OESF riparian conservation strategy is to achieve the minimum level of riparian protection necessary to sustain functioning riparian systems, as well as to provide explicit guidelines for riparian management in order to meet this objective. The riparian conservation objective is the same for both proposed OESF action alternatives. Consequently, the proposed management strategies for riparian conservation are identical for OESF Alternative 2 (Unzoned Forest alternative) and OESF Alternative 3 (Zoned Forest alternative).

The OESF riparian conservation strategy, in reality, constitutes the minimum requirements for implementing the DNR Forest Resource Plan (1992) on state-managed lands of the western Olympic Peninsula. It contains guidelines for minimizing forest-management-related impacts to unstable hillslopes and channel margins, wetlands, riparian and aquatic habitat, and water quality/quantity, as required by the resource plan. In addition, this strategy proposes to carry out riparian management via watershed analyses, landscape planning, monitoring, and research, per the policy direction of the resource plan. Such steps beyond present management practices are warranted by the substantial body of evidence pointing toward the physical and ecological decline of riparian habitat and water quality on state-managed lands of the western Olympic Peninsula. As discussed in Section 4.4.2.2 ("Affected Environment - Current Conditions of the Riparian System"), most major river systems in the OESF, or tributaries to those systems: (1) are water-quality-limited (Washington Department of Ecology 1994); (2) support fish stocks that are depressed, near extinction, or of unknown status (WDF et al. 1993); and, (3) exhibit other signs of habitat degradation (e.g., chronic mass-wasting and road-related sedimentation, extensive blowdown of riparian buffers, declines in volumes of coarse woody debris, structural and compositional homogeneity of riparian stands). Section 4.4.2.2 also describes the positive measures that have been taken over the past decade by DNR to reduce rates of mass wasting, improve road construction and maintenance, and regain some physical and ecological complexity in riparian sites. All of

the proposed management alternatives are expected to build on these successful conservation measures.

Section 4.4.2.3 ("Evaluation of Proposed Alternatives in the OESF - Riparian Habitat") evaluates the consequences to nine key environmental parameters associated with riparian management under Alternatives 1, 2, and 3. These expected outcomes are summarized in Matrix 4.4.2b. Assuming that the DNR Forest Resource Plan (1992) is implemented fully throughout the OESF, Alternative 1 (No Action) is expected to provide adequate levels of protection to areas of mass wasting and channel-bank instability, long-term sources of in-channel coarse woody debris, stream habitat (i.e., from impacts related to sedimentation, roads, and changes in water temperature), nutrient productivity, and riparian habitat (i.e., from impacts related to forest harvest). Alternatives 2 (Unzoned Forest) and 3 (Zoned Forest) are expected to provide the same or slightly greater protection to areas of mass wasting and channel-bank instability, and long-term recruitment of in-channel coarse woody debris. These alternatives also are expected to provide greater levels of protection to parameters that are protected inadequately today. These parameters include the structural integrity of riparian buffers (i.e., from windthrow and other peripheral disturbances related to forest management), recruitment of coarse woody debris to flood plains and riparian forest floors, sediment and water delivery from forest roads, regulation of stream flow, nutrient productivity, microclimate control, structural and biological complexity of stream and streamside habitat, cumulative effects, and the integration of physical and ecological processes in riparian zones with those of upland forests. Section 4.4.2.3 also describes the uncertainty with regard to these predictions that stems from incomplete databases and lack of present scientific and management knowledge in some areas. The environmental consequences of research and experimentation in riparian areas is also discussed.

Matrix 4.4.2a: Management strategies for alternatives related to the OESF Planning Unit

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Riparian			
General strategy	Protection of unstable areas by Washington Forest Practices Rules, DNR Forest Resource Plan, and existing agreements (such as the Hoh Agreement regarding unstable slopes).	Resource protection and natural restoration with a long-term effort to find management and conservation solutions through experimentation and active resource management. Laws of general applicability and existing policies and agreements continue to be in effect.	Same as Alternative 2.
Riparian protection	Protection of riparian areas ranges from the minimums allowed by Washington Forest Practices Rules to substantially greater protection to meet site-specific needs. Harvest restrictions range from minimal to maximum (no-harvest) in buffers. Management activities can occur provided that they do not conflict with the Washington Forest Practices Rules and the resource protection objectives of the DNR Forest Resource Plan.	Relies on watershed-level assessments of physical and biological conditions of riparian forests for determining the level of protection over long term. Interim management strategies and buffer-width guidelines provided while assessments are completed. Strategies remain in effect through interim phase landscape planning and implementation of landscape plans. Harvest restrictions range from moderate (partial-cut) to maximum (no-harvest) in buffers. Management activities can occur provided that primary conservation objectives are met.	Same as Alternative 2.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Riparian (continued)			
Interior-core buffers	Current riparian management areas fall into two categories: (1) those that average 144 feet (horizontal distance) on Type 1 Waters, 134 feet on Type 2 Waters, 92 feet on Type 3 Waters, 87 feet on Type 4 Waters, and 95 feet on Type 5 Waters [totals approximately 55% of the riparian areas in the OESF]; and, (2) those that fall below these averages. Timber will be removed only when adequate protection can be provided to fish and other nontimber resources, as per Forest Resource Plan.	Interior-core buffers derived from statistical analysis of No Action buffer strategy. Interior-core buffers designed to minimize mass wasting and protect/aid natural restoration of physical and ecological riparian processes and functions. Harvest may occur if it promotes these primary objectives. All Type 1 through 4 Waters, and most, but not all, Type 5 Waters, will have interior-core buffers. (Buffers expected to average 150 feet on Type 1 and 2 Waters; 100 feet on Type 3 and 4 Waters; Type 5 Waters will be highly variable.) Working hypothesis is that buffers designed to reduce mass wasting will be wide enough to protect and sustain ecological functions of streams and streamside forest.	Same as Alternative 2.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Riparian (continued)			
Exterior buffers	No provision for exterior buffers.	Exterior-core buffers designed experimentally to protect the integrity of the interior-core buffer from damaging wind disturbances. Initial experimental hypothesis about average widths: Type 1 through 3 Waters = 150 feet; Type 4 and 5 Waters = 50 feet; however, may range from zero to a few hundred. Light partial cutting and experimental harvest allowed.	Same as Alternative 2.
Unstable Hillslopes and Mass wasting	Protected by Forest Resource Plan policies, including landscape planning, and Forest Practices Rules (Class IV-Special).	See interior-core buffer strategies above.	Same as Alternative 2.
Road Network Management	Implement Forest Resource Plan direction to develop and maintain road system that integrates management needs and controls adverse environmental impacts on the forest environment.	Implement Forest Resource Plan direction to minimize adverse environmental impacts from roads. Develop comprehensive road maintenance plans that include annual inventories of road conditions, aggresive maintenance, stabilization, and access control to minimize management and environmental problems; and controls on (continued)	Same as Alternative 2.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Riparian (continued)			
Road Network Management (continued)		expansion of road network densities. Consistently apply and, when appropriate, update standards for quality new road construction and appropriate placement based on current and new knowledge and technology.	
Hydrologic Maturity	Forest Practices rain-on-snow regulations are in effect until watershed analysis is conducted; hydrologic maturity issues also may be addressed through landscape planning.	Forest Practices regulations remain in effect. Hydrologic maturity also addressed through landscape planning. Strategy promotes a more diverse mosaic of forest ages and composition across the landscape; for example, partial cuts and multi-age stands. Knowledge gain through research.	Forest Practices regulations remain in effect. Hydrologic maturity also addressed through landscape planning. Multi-age management less evenly applied across the landscape due to zoning older forests for owl habitat and riparian conservation and more intensively managed forests outside owl areas. Knowledge gain through research.
Wetlands Protection	Wetlands will be protected through full implementation of FRP Policy No. 21 - "no net loss of acreage or function." Guidelines for implementation would contain the same protection measures as (continued)	Buffer widths based on average site-potential tree heights. Average buffer widths expected to be 150 feet on forested wetlands greater than 5 acres and 100 feet on forested wetlands 0.25 to 5 acres. Harvest allowed within forested wetlands and (continued)	Same as Alternative 2.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Riparian (continued)			
Wetlands Protection (continued)	described in HCP Alternative B.	buffers; will retain at least 120 $feet^2$ basal area and design buffers for windfirmness. No harvest within 50 feet of non-forested wetland's edge. Harvest within remaining buffer will be designed to maintain windfirmness. Leave trees will be representative of dominant and co-dominant species in the wetland's intact forest edge. Conservation strategy to be integrated with research and monitoring strategies.	

4.4.2.2 Affected Environment - Current Conditions of the Riparian System

Terminology - Throughout Section 4.4.2, the term "riparian" includes both riparian (streamside) and aquatic (stream) environments. The term "riparian buffer" refers to zones of active management along streams, in which the primary management objective is to protect and aid natural restoration of riparian processes and functions. Active management might include (see DNR 1996a, Chapter IV.E.3 for further discussion): (1) timber removal to manipulate stand compositions (e.g., hardwood-to-conifer conversions) and structures (e.g., creating multi-storied canopies, forest openings or closures, windfirm buffer edges); (2) stream and stream bank restoration activities; and, (3) maintenance of existing roads and road crossings. Action plans for (1) and (2) must demonstrate how the primary management objective will be achieved. Buffers in which no timber harvest will occur are referred to specifically as no-harvest.

4.4.2.2a Water bodies

(1) Streams

According to the geographic information systems (GIS) database managed by DNR, there are 2,531.77 miles of streams in the proposed OESF. Stream mileage for each water type is as follows: 87.30 miles (3 percent of the total) are classified as Type 1 Waters; 44.70 miles (2 percent) as Type 2 Waters; 285.69 miles (11 percent) as Type 3 Waters; 261.46 miles (10 percent) as Type 4 Waters; and 1852.63 miles (73 percent) as Type 5 Waters.

There are two known sources of error in the GIS database, which reduce the level of confidence in these statistics. The first pertains to streams and other water bodies not included in the database due to omissions or inaccurate mapping. Current field inventories in selected areas indicate that numerous streams and wetlands are missing, a fair number of which are Type 2 and 3 Waters. The second problem relates to inaccurately typed streams, most of which are Type 4 and 5 Waters that should be upgraded. For example, the number of stream miles classified as Type 5 probably is too high. Recent studies on Quinault Indian Nation lands immediately to the south of the OESF (Mobbs and Jones 1995) show that 88 percent of sampled Type 4 Waters actually meet the minimum width requirements for anadromous Type 3 Waters. In addition, preliminary analyses of Type 4 and 5 Waters on low-gradient terraces of the Hoh River valley (Hoh Tribe and DNR 1993) suggest that as much as 50 percent of these streams meet the requirements for anadromous Type 3 Waters. The number of unmapped Type 5 Waters excluded from the GIS database, however, partially offsets the number of incorrectly typed streams. Realistically, Type 5 Waters probably constitute about 40 percent of actual stream miles on the proposed Experimental Forest. DNR presently is working on correcting GIS database errors to account for all sources of error for all stream types.

Major river systems (fourth-order or larger) draining the OESF include the Queets, Clearwater, Hoh, Bogachiel, Calawah, Sol Duc, Quillayute, Dickey, Ozette, Sekiu, Hoko, Clallam, and Pysht Rivers. A number of smaller coastal rivers, containing important salmonid habitat, enter the Pacific Ocean along the west and north coasts of the OESF; they include the Kalaloch, Cedar, Mosquito, Goodman, Sooes, Deep and Twin Creeks. The Queets and Hoh Rivers are governed by glacial dynamics at their headwaters on Mount Olympus in Olympic National Park. Diurnal and seasonal fluctuations in flow discharges result from different rates of glacial ablation (evaporation and melting) and have been monitored sporadically over the last century at U.S. Geological Survey gauges located 30 to 40 river miles downstream from both headwaters. The morphologies of most rivers and streams in the OESF have been created or modified by Pleistocene continental glaciation and/or more recent alpine glaciation. The preponderance of Type 4 and 5 Waters derives from the terrain characteristics and precipitation regimes of the western Olympic Peninsula. Steep, erodible terrain and heavy annual precipitation promote high densities of low-order (e.g., Type 4 and 5) channels, particularly in U-shaped glacial valleys like the Hoh, Bogachiel, and Sol Duc drainages. Current GIS information indicates that the average stream densities in the OESF are 0.21 mi/mi^2 for Type 1 Waters, 0.11 mi/mi^2 for Type 2 Waters, 0.68 mi/mi^2 for Type 3 Waters, 0.63 mi/mi^2 for Type 4 Waters, and 4.44 mi/mi^2 for Type 5 Waters. These numbers are likely to change somewhat, however, as GIS databases are corrected and updated.

(2) Lakes and wetlands

The OESF contains approximately 500 acres of lakes, ponds, and open-water wetlands. Ozette Lake is the largest freshwater body on the western Olympic Peninsula and covers approximately 18 square miles. Although located in Olympic National Park, it is separated from state and private timberlands by only a few hundred feet along its southern, eastern, and northern perimeters. Extensive forested wetlands occur in the coastal lowlands and valley bottoms of the major river systems. They support some of the largest and oldest stands of western redcedar and Sitka spruce in the world (Kirk et al. 1992). Several are known to be important cultural sites for the Native American tribes of the western Olympic Peninsula, providing camas, berries, cedar, and a number of other resources key to a traditional way of life. Seasonally flooded wetlands provide vital refugia and overwintering habitat for salmonids during periods of high discharge and low food availability. Juvenile coho salmon, for example, seek refuge in small spring- and pond-fed tributaries at the base of steep valley walls in the Clearwater River basin (Cederholm and Scarlett 1982; Cederholm and Reid 1987). Forested wetlands dominate the low-gradient, alluvial valleys of the lower Queets, Clearwater, Kalaloch, Hoh, Mosquito, Goodman, Bogachiel, Quillayute, Dickey, and Ozette Rivers and their tributaries.

(3) Estuaries and nearshore marine areas

The OESF is separated from nearshore marine and estuarine environments by federal (Olympic National Park) and private lands. These areas are important for salmonid rearing, and good estuarine conditions enhance the probability of marine survival for anadromous organisms (Bisson et al. 1992). Land management practices in upstream watersheds, however, can influence the interaction between river flows and tides by changing the water and sediment discharge rates, thereby affecting circulation patterns essential to maintaining estuarine food webs (Simenstad et al. 1992). Increased rates of landsliding and surface erosion associated with land management activities have supplied artificially high volumes of sediment to river systems on the western Olympic Peninsula (Hoh Tribe and DNR 1993; O'Connor and Cundy 1993; USDA and DNR 1995). It is suspected that river sedimentation contributes substantially to infilling of estuaries and nearshore kelp and algal beds, especially in protected embayments like that at the mouth of the Quillayute River (J. A. Shaffer, Quileute Fisheries, La Push, WA, pers. commun., 1994), as has been demonstrated elsewhere along the West Coast (Stow and Chang 1987; Simenstad et al. 1992; Shaffer and Parks 1994).

There are few estuaries or well-developed nearshore rearing areas for salmonids on the western Olympic Peninsula. The larger estuaries (e.g., Quillayute, Pysht) have been altered by dredging or channel diversions (C. Byrnes, WDFW, Forks, WA., pers. commun., 1994; W. Scarlett, DNR Olympic Region, Forks, WA., pers. commun., 1994). The limited number of natural estuaries, in addition to variable oceanic conditions along dynamic coastlines, make freshwater habitat all the more critical for the survival and persistence of anadromous stocks.

4.4.2.2b Unstable hillslopes

The western Olympic Peninsula differs from other physiographic provinces of the state in its unique combination of soil parent materials, precipitation and soil-saturation regimes, and windthrow characteristics (Thorsen 1989; Henderson et al. 1989). Natural sedimentation rates are high relative to those in other parts of the state because: (1) annual precipitation rates are substantial, ranging across the OESF from 90 to 200 inches/year; and, (2) hillslopes are composed of highly erodible materials derived from deeply weathered, marine sedimentary bedrock and glacial deposits. In addition, tectonic activity along the continental margin has resulted in extensive fracturing, folding, and shearing of the bedrock, which has increased hillslope susceptibility to mass wasting in many parts of the proposed Experimental Forest. Evidence of unstable ground in the OESF includes landslides, channel-bank erosion, erosion of hillslope surfaces, debris flows, dam-burst floods, loose or wet substrates associated with ground-water seeps and springs, and road-related disturbances (e.g., failures of landings and sidecast deposits, unstable cut and fill slopes). In the OESF, the majority of streamside areas exhibit, or have the potential for, unstable channel banks and sideslopes due to inherent terrain characteristics, channel hydraulics, and past disturbances.

Several studies from the western Olympic Peninsula have shown that forest management activities locally have increased the natural rate of mass wasting by as much as several orders of magnitude. Schlichte et al. (1991) determined that rates of mass wasting have increased by 600 to 700 percent since forest harvest and road building began on state-managed lands in the Hoh River basin. O'Connor and Cundy (1993) estimated, from landslide inventories in the North Fork Calawah watershed, that mass-erosion rates for the logging period between 1955 and 1992 exceeded natural rates by 380 to 600 percent. (See also Benda 1993; Shaw 1993; Pentec Environmental 1995; McHenry et al. 1995; Hoh Tribe and DNR 1993.) These calculations of mass-wasting rates are consistent with those reported elsewhere in the Pacific Northwest. Sidle et al. (1985), for example, evaluated 43 landslide inventories completed within the Pacific Northwest and concluded that clearcutting and broadcast burning increase the rate of soil movement through debris slides by 2 to 4 times over rates on unmanaged landscapes, while road construction increases mass-movement rates by 300 times. In addition, these authors found that removing trees on steep, unstable hillslopes like those found in the OESF increases the frequency of debris torrents by 2.5 to 10.7 times that on similar, unmanaged slopes.

A significant percentage of debris avalanches and flows in the OESF are generated in Type 5 channels. Landslide and debris-flow materials typically reach salmonid habitat via Type 4 and 5 Waters because these channels: (1) have steep gradients; (2) are relatively short; and, thus, (3) are capable of delivering materials directly, and often catastrophically, to fishbearing waters. Most Type 5 drainages occupy steep ground on the upper half of valley sidewalls that commonly exceed the angle of repose (i.e., 70 percent) for loose, unconstrained materials. Channel heads and unchannelled depressions immediately upslope of the channel heads are frequent initiation points for mass wasting (Figure 4.4.2). Debris avalanches occurring in these areas can trigger debris flows that scour steep channel reaches and aggrade low-gradient channels (Schlichte et al. 1991; O'Connor and Cundy 1993; McHenry et al. 1995). Low- to moderate-gradient, alluvial channel reaches coincide with the majority of salmonid habitat in the OESF (Hatten 1991; McHenry et al. 1994). Consequently, debris avalanches and flows pose a significant threat to the quality and quantity of fish habitat.

Current practices on DNR-managed lands. Today, approximately 55 percent of riparian areas are protected by riparian management zones (i.e., limited-harvest to no-harvest buffers) that have average widths comparable to the OESF interior-core buffers described further in this section (4.4.2.2b). The variability in riparian protection across the OESF is due to a lack of detailed mass-wasting and channel-condition inventories for all portions of the Experimental Forest, and insufficient science staff to assist in the field with analyses of riparian conditions. In addition, DNR is making a transition from a site-specific to a watershed-scale mode of management; consequently, not all riparian areas are treated similarly.

Streamside buffers in the OESF currently exceed protection afforded by the current Washington Forest Practices regulations for Riparian Management Zone (RMZ) widths (WAC 222-30-020(3); WFPB 1995c), especially where they incorporate unstable ground. The intent of these buffers is to protect all unstable ground associated with riparian systems. These riparian buffers are actively managed to promote windfirm, structurally and compositionally diverse, streamside forests capable of maintaining bank stability and functioning ecologically. For example, most Type 4 and 5 Waters located in proposed harvest areas with local slopes exceeding approximately 70 percent have been, or will be, protected by no-harvest or limited-harvest buffers, because of the recurrence and severity of landslides and debris flows that originate in the headwalls of such drainages (e.g., see Benda 1993; Hoh Tribe and DNR 1993; O'Connor and Cundy 1993; Shaw 1993; DNR 1995c; McHenry et al. 1995; S. C. Shaw, DNR Olympic Region, Forks, WA, unpubl. data, 1991-94). Buffer widths for Type 5 drainages currently are determined on the ground by qualified staff and average 95 feet wide. Harvest practices in these areas are not likely to change until a mechanism is invented for stabilizing ground that is prone to failure; such a mechanism, however, does not yet exist. Furthermore, current practices in the Olympic Region often provide greater protection than Forest Practices RMZs in low-gradient, alluvial stream systems (i.e., Types 1 through 3) because Forest Practices RMZs do not adequately protect incised channel margins, unstable terrace and hillslope margins, and flood-plain wetlands.

Figure 4.4.3 provides an example of the extent of riparian protection afforded by current practices in some areas of the OESF. This figure shows, for a portion of the Clallam River watershed, riparian areas with a potential for mass wasting that presently are protected with buffers in which minimal timber harvest (e.g., limited hardwood extraction during conversion to conifer-dominated stands) to no harvest occurs. Mass-wasting sites (e.g., landslide scars, debris-flow tracks, areas of channel-bank erosion and collapse) in this watershed have been identified by aerial photo and field analyses. Buffer widths range from 50 feet to 850 feet on either side of the active channel margin for all streamside areas susceptible to mass wasting.

Table 4.4.1 compares the regulated Forest Practices RMZ widths (WFPB 1995c) with average riparian-buffer widths currently being placed on some streams in the OESF. These values reflect current practices on approximately 55 percent of state-managed lands on the proposed Experimental Forest. The remaining 45 percent primarily have been managed according to Washington Forest Practices Rules. Buffer widths are shown in this table as horizontal and slope distances. Conversions of horizontal distances to slope distances are based on average slope gradients, measured perpendicular to the stream channels. Average slope gradients on the OESF are: (1) less than 15 degrees (27 percent) for Type 1 and 2 Waters; (2) less than 20 degrees (37 percent) for Type 3 Waters; and, (3) less than 36 degrees (73 percent), or the angle of repose for loose soils and other unconsolidated materials, for Type 4 and 5 Waters.

The average width of riparian buffers currently in place on the OESF was determined by calculating the statistical mean by stream type (see Table 4.4.1). Buffer widths were sampled throughout the proposed Experimental Forest. The number of samples ranged from 100 to approximately 300 for each stream type. Statistical means were computed by: (1) dividing the riparian-buffer area by stream length for the entire typed stream; or, (2) randomly sampling riparian-buffer widths from about 100 streams of the same type, and taking the mean value of the sample. Buffer widths range locally for each stream type from the minimum Forest Practices RMZ width (see Table 4.4.1) to 850 feet (horizontal distance) on either side of the active channel margin for Type 1 and 2 Waters and 500 feet for Type 3 through 5 Waters.

Current protection of some but not all Type 5 channels (e.g., those located on 55 percent of state-managed lands in the OESF) involves a no-harvest riparian buffer. Buffers on Type 5 channels range from no protective buffer on stable ground to approximately 500 feet on highly unstable ground. These buffers generally provide the minimum level of protection for incised channels and headwalls, as well as for incorporating any unstable ground on adjacent hillslopes. On the OESF, approximately 90 percent of Type 5 channels have identifiable channels, occupy unstable ground, and directly contribute sediment, water, organic debris, and nutrients to the channel network. An identifiable channel is one in which the channel banks are well-defined and measurable (Chorley et al. 1984). An additional 5 percent also have identifiable channels that transport materials downstream, but these channels occupy stable ground and might not require full buffer protection in all instances. The remaining 5 percent exert a negligible influence on aquatic or riparian habitat and, thus, require no special protection. Channels in this latter group include those not connected to the watershed stream-network (e.g., sinks, seasonal wet areas excluding forested wetlands), slope depressions with no identifiable banks (e.g., swales with a continuous groundcover), and artificial channels that do not support aquatic habitat (e.g., ditches, yarding trails).

Current protection of Type 5 channels occupying unstable ground includes (see Figure 4.4.2):

(1) the streambed and banks throughout the entire length of the Type 5 channel, from the channel head downstream to the channel confluence, and from the active channel margin laterally outward to the topographic break-in-slope (i.e., the change in slope that physically separates the channel from the rest of the hillslope);

(2) the channel head, which is defined as the upslope limit (i.e., laterally and longitudinally) of a channel whose banks are well-defined (Montgomery and Dietrich 1988); and,

(3) the unchannelled depression, including the channel headwall and any portion of the hillslope extending to the ridgeline that is necessary to protect the integrity of the headwall.

Unchannelled depressions have no surface channels with identifiable banks. They collect ground water, sediment, and organic matter over the course of many decades and episodically release these materials into the channel head when gravitational forces, pore-water pressures, or ground disturbances overcome soil cohesion, root strength, and other resistive forces (Dietrich and Dunne 1978). Ground disturbances include natural and forest-management-related disruption of the soil horizons, vegetation, surface and ground- water flow regimes, and topographic relief (e.g., removing portions of the slope during road construction). Unchannelled depressions (also referred to as bedrock hollows and zero-order basins) are some of the common sources of debris avalanches in steep terrain on the proposed Experimental Forest (Hoh Tribe and DNR 1993; Shaw 1994; DNR 1995c).

No-harvest buffers on Type 5 channels, designed to protect unstable ground, benefit ecological functions of riparian systems, as well as physical processes. These benefits include: (1) protecting channel beds and banks, which are important habitat for macroinvertebrates and amphibians; (2) ensuring long-term sources of coarse woody debris and forest litter for nutrient production; and, (3) protecting water quality by regulating sediment delivery and stream shade.

4.4.2.2c Road network and densities

Road construction has increased the rates of landsliding in the OESF. Whereas hillslope surface erosion is a minor factor on the western Olympic Peninsula, road surface erosion is a dominant concern. For example, approximately 60 percent of the debris avalanches (i.e., shallow, rapid landslides) in the Hoh and Clearwater drainages are related to roads and landings (Hoh Tribe and DNR 1993). Additionally, O'Connor and Cundy (1993) found that 45 percent of the total mass erosion volume in the North Fork Calawah watershed was associated with roads.

Road densities on the OESF average 3.21 mi/mi^2, and range from less than 1.0 mi/mi^2 to 7.4 mi/mi^2. Much of the road network in the OESF to the south of Forks was built during the late 1960s and 1970s, whereas a considerable number of the roads to the north are reclaimed railroad grades from turn-of-the-century rail logging. Truck roads primarily were constructed using sidecast techniques, in which road beds were created on top of overburdened and organic material removed during road construction. Substantial amounts of organic debris and sediment were pushed over the side during excavation of roadbeds. In addition, many of these roads were built across unstable and over-steepened ground in mid-slope areas. A preferred spot for locating a road segment was the unchannelized depression (i.e., bedrock hollow; see Figure 4.4.2) just upslope of a channel head because relatively less substrate needed to be excavated during the process. These areas are now known to be frequent initiation points for debris avalanches and flows (Dietrich and Dunne 1978; Hoh Tribe and DNR 1993; DNR 1995c). Sidecast collapse, due to decay of incorporated organic debris and downslope mass movement under the forces of gravity, especially in saturated soils, is one of the principal causes of road failures in the OESF.

Old railroad grades often were built on channel banks and flood plains, thereby increasing the potential for sediment delivery to streams via surface erosion and roadbed collapse. Streams flowing northward to the Strait of Juan de Fuca were often used during the 1940s and 1950s as roads and conduits for splash damming (McHenry et al. 1994; DNR 1995c; see also historical photo archives, Merrill and Ring Timber Company, Pysht, WA; USFS Sol Duc District, Forks, WA; DNR Olympic Region, Forks, WA).

Current road-building methods are vastly improved over historic practices, although problems with road location, sediment delivery, and water drainage still exist on a substantial percentage of active and inactive roads. Most new roads are fully or partially benched, so that the road prism rests on natural ground. Excavated material is hauled, sometimes many miles, to stable storage sites in which the potential for sediment delivery to streams is minimized. In addition, ridgetop roads are built wherever possible to avoid unstable ground on sideslopes and reduce the potential for altering surface-runoff and ground-water regimes.

4.4.2.2d Riparian forests and their susceptibility to windthrow

Relatively little quantitative information exists regarding wind behavior and orographic effects on the Olympic Peninsula. Qualitative analyses (Agee 1993, 1994) indicate that catastrophic windstorms have occurred in the recent past but are non-cyclic and, therefore, unpredictable. Agee (1994; see also Agee and Edmonds 1992) suggests that large-scale wind disturbances occur, on average, three times per century. The western Olympic Peninsula has sustained three major wind events this century, in 1921, 1962, and 1979. Anecdotal reports indicate significant windthrow activity during 1887 and 1888 (Agee 1994). The most geographically extensive, recorded windstorm occurred in 1921; greater than 40 percent of the trees between the Hoh and Clearwater Rivers were blown down, and 20-40 percent blowdown occurred between the Hoh and Sol Duc Rivers (Agee 1994). Forests modified by the 1921 storm have been mapped across the entire area now designated as the OESF (see Henderson et al. 1989; Agee 1994).

This historical evidence of widespread tree blowdown on the western Olympic Peninsula indicates that streamside forests on the OESF are vulnerable to wind disturbances (Henderson et al. 1989). Tree susceptibility to windthrow varies with degree of exposure relative to the prevailing wind directions, particularly where the boundary between riparian forests and clearcuts is abrupt and perpendicular to the wind direction. The most damaging windthrow events occur during winter storms when soils are saturated and more easily disturbed by wind-generated vibration of tree trunks and their root systems (Agee 1993, 1994; DNR Olympic Region, Forks, WA, unpubl. data, 1990-1994). The process of upending trees and dislodging their root wads can: (1) contribute substantial amounts of sediment and coarse woody debris to streams; (2) increase bank erosion and associated lateral channel migration; and, (3) locally reduce long-term supplies of coarse woody debris by depleting streamside sources of standing timber in a single blowdown event.

Site factors that promote susceptibility to windthrow on the western Olympic Peninsula include wind direction, wind duration and intensity, wind fetch, forest species composition, forest health, precipitation regimes, and soil type and depth (Henderson et al. 1989; Agee 1994). Wind fetch is the distance over which winds accelerate unobstructed by landforms or surface roughness elements such as tree canopies. In addition, patterns of forest harvest and road networks can accelerate blowdown in adjacent stands by creating gaps and corridors for wind to penetrate (Franklin and Forman 1987; Chen et al. 1992; DNR Olympic Region, Forks, WA, unpubl. data, 1990-1994). Western hemlock, the dominant conifer species on the western Olympic Peninsula, is particularly prone to windthrow because it has a shallow root system. Sitka spruce, a co-dominant species that grows predominantly on river terraces, also is strongly susceptible to wind damage because of its shallow root system. Mature western redcedar, on the other hand, tends to resist windthrow because it has a deeper root system and a greater diameter-to-height ratio than mature western hemlock and Sitka spruce. Following extreme windstorms, therefore, remnant stands typically contain a high percentage of late seral-stage dominants with large diameter-to-height ratios; these trees usually survived previous disturbances also (Franklin and Forman 1987; Agee 1994).

Riparian buffers razed by windthrow are considered by foresters and biologists on the western Olympic Peninsula as economic and ecologic losses. Retrieving windthrown logs can be prohibitively expensive or operationally difficult in mountainous terrain. In addition, buffers flattened by the wind may not provide adequate stream shade, stream-bank stability, sediment traps, and other important biological and physical riparian functions. Furthermore, long-term sources of coarse woody debris are lost when a buffer blows down all at once, as all the wood winds up in the channel at one time.

Two critical concerns with regard to habitat conservation on the OESF are the loss of long-term sources of coarse woody debris and increased bank erosion associated with tree blowdown and root upheaval along stream margins. Coarse woody debris is a primary factor in creating and maintaining aquatic habitat in Type 1 through 5 Waters throughout the proposed Experimental Forest (Grette 1985; Hatten 1994; Grette et al. in prep.). Coarse woody debris also moderates channel flows and controls rates of sediment transport in the OESF (Fetherston et al. 1995). Bank erosion and extensive wind damage to riparian forests are most likely to occur in low-gradient, alluvial valleys (i.e., Type 1 through 3 Waters) because they are more exposed to winds blowing directly off the Pacific Ocean than are incised valleys in upslope terrain. Incised valleys (i.e., some Type 3 Waters and most Type 4 and 5 Waters) commonly are shielded orographically by surrounding peaks and ridges and, hence, are less susceptible to windthrow except near the top of ridgelines.

Bank erosion can supply the majority of sediments to low-gradient, alluvial channels where sediment delivery from roads and mass wasting is not the dominant factor (S. C. Shaw, DNR Olympic Region, Forks, WA, unpubl. data, 1990-1994). Bank erosion also occurs in steep, incised valleys (e.g., Type 4 and 5 channels); however, landslides and debris flows generally overwhelm the sediment budget of these streams, contributing as much as 95 percent of the sediments transported through the channel network (e.g., Benda 1993; Shaw 1993). Hence, bank erosion is a significant problem in low-gradient valleys prone to wind disturbance. Coincidentally, these areas contain most of the anadromous habitat on the western Olympic Peninsula (Schlichte et al. 1991; Hoh Tribe and DNR 1993; McHenry et al. 1994, 1995; DNR 1995c). Controlling windthrow and bank erosion, therefore, is a critical factor in maintaining viable anadromous habitat.

It is not possible to predict from historic disturbances when a catastrophic windstorm might occur in the future, let alone the geographic extent of such an event. Of more immediate concern for forest management during the life of this HCP are the moderate storms that recur annually or semiannually. These storms reduce densities of standing trees within riparian buffers over time. Average winds from moderate winter storms range between 50 and 70 miles per hour. These winds are capable of leveling 25- to 100-foot-wide buffers in intensively managed, low-gradient, alluvial valleys and on exposed ridgetops, during one storm or over the course of several years (DNR Olympic Region, Forks, WA, unpubl. data, 1990-1994). Typically, buffers on flat ground experience significant blowdown (e.g., 20-60 percent of the trees) in the first 3 to 5 years following harvest because wind fetch increases following removal of trees in harvest units adjacent to riparian buffers. Mobbs and Jones (1995) found lower percentages of windthrow in riparian buffers on Quinault Indian Nation lands than those recorded on the OESF. Their results, however, were obtained within 1 year of harvest on adjacent lands, following a fairly mild winter, and hence might not represent the amount of windthrow that actually could occur over several winters.

Current practices on DNR-managed lands. Stand blowdown is recognized as a significant problem for timber management on the western Olympic Peninsula because of the proximity of DNR-managed lands to the Pacific Ocean, the intensity and duration of storms, and the fragmented nature of mature timber stands. Currently, treatment of windthrow issues on the OESF is sporadic and limited. Over the past decade, foresters working with individual timber units have attempted to reduce blowdown potential by topping trees along unit edges, feathering unit margins to avoid abrupt, straight edges between mature timber and clearcuts, and clumping rather than scattering individual leave trees. None of these trials, however, was documented or monitored, nor were they replicated in sufficient numbers across the landscape to permit a systematic analysis of trial success or failure.

4.4.2.2e Fish habitat conditions

(1) Status of anadromous and resident fish populations

Concern about the health of aquatic ecosystems in the OESF has magnified with the identification of native, anadromous fish stocks that are in decline and require new management considerations for their protection and recovery. The Salmon and Steelhead Stock Inventory (WDF et al. 1993) lists 10 salmonid stocks as depressed (see Table 4.4.2) in rivers draining the proposed Experimental Forest. Supplemental information provided by the Makah Tribe (E. Currence, Makah Tribe, Neah Bay, WA, pers. commun., 1994) and Lower Elwha S'Klallam Tribe (M. McHenry, Lower Elwha S'Klallam Tribe, Port Angeles, WA, pers. commun., 1994) indicates two additional depressed stocks, as well as one stock near extinction and another extinct. Depressed stocks are defined as those whose production is "below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely." (WDF et al. 1993).

None of these salmon and steelhead stocks currently are listed under the Endangered Species Act. In September 1994, the National Marine Fisheries Service initiated comprehensive status reviews for populations of Pacific salmon and anadromous trout in Washington, Oregon, Idaho, and California. A coast-wide proposal was made to list coho salmon as a threatened species in July 1995 (S. Landino, NMFS, Olympia, WA, pers. commun., 1995). At that time, it was determined that species listing was not warranted in the Evolutionarily Significant Unit (ESU) encompassing the northwestern Olympic Peninsula, which includes the OESF. This determination was based on a recently completed status review of coho for six ESUs identified in the Pacific Northwest. The review included analyses of the best scientific and commercial information and were conducted by coho salmon experts from federal, tribal, state, and local agencies, as well as academia and other interested parties. The National Marine Fisheries Service will continue to monitor the ESU including the OESF and will encourage conservation measures by land managers to ensure that coho salmon populations remain healthy. Status reviews of other anadromous fish are being prepared and may result in proposed listings or other conservation measures that would apply to the OESF.

Several resident fish populations in the OESF are known to be in decline, while others are considered healthy or of unknown status. The bull trout and Olympic mudminnow currently are candidates for listing under the Endangered Species Act. Bull trout/Dolly Varden are found in glacially-influenced rivers like the Hoh system, in which they are anadromous, and the Queets system, in which they are resident (Rodrick and Milner 1991; Mongillo 1993; W. Scarlett, DNR Olympic Region, Forks, WA, pers. commun., 1994). The Washington Department of Fish and Wildlife identifies bull trout as a species of concern and restricts the killing of caught fish. The Olympic mudminnow inhabits river-drained ponds and wetlands in the coastal lowlands of the proposed Experimental Forest, particularly in the Queets and Lake Ozette drainages (Rodrick and Milner 1991). These species most likely are impacted adversely by the same factors responsible for the decline of anadromous stocks (Williams et al. 1989).

(2) Physical and biological fish-habitat conditions

A significant factor in the decline of anadromous fish populations in river systems of the OESF is the alteration and destruction of aquatic habitat and forage (Cederholm and Salo 1979; Cederholm et al. 1981b; Tagart 1984; Cederholm and Reid 1987; Schlichte et al. 1991; Ralph et al. 1994; McHenry et al. 1994, 1995; DNR 1995c). Habitat degradation is evidenced by changes in habitat quantity, quality, and degree of fragmentation; water quantity and quality; nutrient cycling; stream productivity; species diversity; structural diversity; obstruction of the physical and biological interactions between the channel and its flood plain; and the frequency, timing, and volume of sediments entering streams. Similar to other streams in the Pacific Northwest (e.g., Megahan 1982; Sullivan et al. 1987; Bisson et al. 1988b), the most common changes in channel habitat associated with forest management practices have been the reduction in pool size and volume due to sediment infilling, and loss of pool-forming structures such as coarse woody debris (McHenry et al. 1994; Grette et al. in prep.).

Other critical concerns include the rates and timing of commercial and sport fish harvest, obstacles to upstream fish migration, the loss of genetic integrity due to artificial propagation practices and the introduction of nonlocal species, and the cumulative effects of these factors when combined (e.g. Williams et al. 1989; Nehlsen et al. 1991; Bisson et al. 1992). DNR recognizes that it cannot rectify all aspects of stock decline, particularly with regard to hatchery practices, fisheries overharvest, and habitat alteration in basins with multiple land-ownership boundaries. DNR can affect riparian management on private lands, through its regulatory division. Washington Forest Practices (1995) regulations for Riparian Management Zones (RMZs) are less stringent than the present Forest Resource Plan (1992) for DNR-managed lands and have proven inadequate to fully protect riparian functions in some situations. A desired outcome of DNR management is to maintain and enhance habitat on lands under the jurisdiction of the department and to foster partnerships with adjacent landowners, outside the context of the HCP agreement, in forestwide efforts to protect and restore aquatic resources.

Mass wasting and channel sedimentation. Stream tributaries supporting fish habitat in every major watershed within the proposed Experimental Forest (e.g., Clearwater, Hoh, Bogachiel, Sol Duc, Calawah, Quillayute, Ozette, Hoko, Sekiu, Clallam, and Pysht) have been influenced or altered measurably during the last century by: (1) debris-flow scour; (2) debris dam-burst-flood erosion and deposition; (3) chronic bank collapse and raveling along channel margins; (4) loss of stream components that regulate channel movements and sediment transport, such as coarse woody debris (Fetherston et al. 1995); and, (5) harvest practices that included splash damming, road building, and yarding in stream channels and flood plains. [See the following reports for supporting information: Fiksdal 1974; Cederholm and Lestelle 1974; Wooldridge and Larson 1980; Cederholm et al. 1981b; Cederholm and Reid 1987; Schlichte et al. 1991; Jones & Stokes Associates and DNR 1991; Benda 1993; O'Connor and Cundy 1993; Shaw 1993; McHenry et al. 1994, 1995; O'Connor 1994; DNR 1995c; Grette et al. in prep.; USDA and DNR 1995]. Streams that are aggraded with sediment from landslides and road failures typically widen, shallow, and shift laterally across their flood plains, thereby increasing bank erosion (e.g., see McHenry et al. 1995). Natural and harvest-related mass-wasting events have the greatest potential for degrading habitat and water quality in: (1) channels draining north from high ground into the Strait of Juan de Fuca, where some road-related debris flows have traveled the length of main channels from their headwaters to the ocean (average distance 5 miles; e.g., see McHenry et al. 1995); and, (2) short, steep tributaries of the major West Coast river systems, where debris flows frequently scour fishbearing streams from ridgetop to valley bottom (e.g., Schlichte et al. 1991; O'Connor and Cundy 1993).

The effect of landslide-related stream sedimentation on salmonid spawning and rearing is not documented fully on the western Olympic Peninsula. Studies in the Hoh River drainage and adjoining watersheds, however, have demonstrated that sidecast-constructed and poorly maintained roads contributed significant amounts of sediment via landslides and debris flows to spawning areas, particularly in side, terrace, and valley-wall tributaries to the third- and fourth-order mainstem channels (Cederholm and Salo 1979; Logan et al. 1991). Large volumes of silt related to these disturbances were shown by Cederholm and Reid (1987) to be detrimental to survival of salmon eggs and fry, as well as macroinvertebrate populations on which salmonids prey (McHenry 1991). In five major watersheds on the OESF (i.e., Ozette, Pysht, Clallam, Hoko, and Sekiu), McHenry et al. (1994) found that levels of fine sediments in stream gravels exceed volumes considered detrimental to incubating salmonid embryos.

Sedimentation rates in excess of natural background rates are a significant concern to state, tribal, and federal fish biologists on the western Olympic Peninsula (e.g., see Cederholm et al. 1981b; Schlichte et al. 1991; Hoh Tribe and DNR 1993; McHenry et al. 1994; USDA and DNR 1995). For example, sediment-budget analyses of Green Creek, a tributary to the Pysht River, indicated that sediment loads delivered to streams by forest-management-related landslides and road failures have residence times greater than 60 years (Benda 1993; Shaw 1993). Hence, approximately 90 percent of fine and coarse sediments transported into Green Creek during the last half-century are still stored in the channels as bed and bar deposits averaging 2 feet thick. These observations are consistent with channel cross-sectional profiles measured repeatedly over the course of several years by Ralph (S. C. Ralph, University of Washington, Center for Streamside Studies, Seattle, pers. commun., 1991). Green Creek is representative of stream channels located throughout the northern portion of the OESF. Based on extrapolations of calculated sediment-discharge rates for Green Creek, it will take an estimated 100 years or more for channel flows to flush unnaturally excessive volumes of stored sediments from the stream network.

Coarse (large) woody debris. One of the most significant long-term effects of forest management on aquatic habitat in the OESF has been changes in the distribution and abundance of large coniferous wood in channels, which serve to regulate sediment and flow dynamics, habitat (e.g., pool) formation, and channel morphology (Hatten 1994; Grette et al. in prep.). Large pieces of conifer wood are preferred as in-channel structure because they have greater influences on channel hydraulics, residence times, and longevity than smaller pieces or deciduous materials that decay rapidly (see Section 4.1.4.5). Average volumes of large conifer debris are low in the OESF compared with adjacent unmanaged landscapes (Hatten 1994; Grette et al. in prep.), due to historical practices of harvesting riparian areas and cleaning streambeds of organic debris, as well as accelerated rates of riparian disturbance from mass-wasting events. Approximately 70 percent of riparian forests in the OESF are dominated by red alder (*Alnus rubra*) and/or young (i.e., less than 20-year-old) conifer plantations, and thus do not provide sources of coarse woody debris in the short term if riparian buffers have been added recently, or in the long term if no buffers are required (e.g., on Type 4 and 5 Waters). In addition, woody debris removal, practiced on the Olympic Peninsula and elsewhere in the Pacific Northwest during the last century, has had substantial and adverse effects on channel morphology. Streams were cleaned of woody debris to aid river navigation, stream transport of logs, and fish passage (Sedell and Luchessa 1982; McHenry et al. 1994).

Recently, Grette et al. (in prep.) performed a 10-year follow-up study of streams analyzed by Grette (1985) to compare the types, decay conditions, and distribution of coarse woody debris in channels. These surveys included 28 streams in eight watersheds (Queets, Hoh, Mosquito, Goodman, Calawah, Hoko, Clallam, and Pysht) located on private, state, and federal lands in the OESF. Grette et al. concluded that landowners currently are often managing for 50 percent of the volume of coarse woody debris typically encountered in naturally disturbed, old-growth stream sites. Old-growth sites harvested between 1985 and 1995 experienced a 50 percent reduction in channel wood volume. All but the oldest second-growth sites showed no net increase in wood volume during 60 years following harvest of streamside and adjacent forests. These data point toward a steady decline in the volume of coarse woody debris entering channels in the OESF.

In the OESF, coarse woody debris also plays an essential role in maintaining the physical and biological functions of off-channel riparian areas and flood plains. Large downed trees provide physical stability to active flood plains by trapping sediment carried overbank by flood waters and regulating flood flows, as currently is being documented in the Queets River system (K. Fetherston, University of Washington, Seattle, pers. commun., 1994). Flood-plain logs help to create off-channel wintering areas (e.g., ponds, side channels) for salmon. They also are an essential component of channel and flood-plain nutrient cycles (Marra 1995). Several arthropod groups (e.g., detritivores, parasites, fungivores, predators) inhabit coarse woody debris and are a vital link in the nutrient breakdown and cycling processes. Flood-plain logs often act as the only regeneration sites for conifers and other vascular plants (i.e., nurse logs), particularly where soils remain saturated for extended periods and, hence, are too wet to germinate seedlings (Maser et al. 1988).

4.4.2.2f Status of other riparian-dependent species

The current status of riparian-dependent species that inhabit the OESF is discussed in Section 4.5.3. The distribution and habitat relationships of riparian-dependent fauna other than fish generally are not well known. The lack of information is proportionately greatest for the more biologically rich, low-elevation forested areas, such as the drainage basins bordering the Strait of Juan de Fuca. An analysis of the associations between wildlife and plant communities in which they commonly are found (Wilhere 1995) indicates that 52 terrestrial vertebrate species are strongly or very strongly associated with riparian and wetland communities. At present, three of these species are candidates for listing by the state and federal governments under the Endangered Species Act. They are the Cascades frog, Van Dyke's salamander, and the Harlequin duck, each of which spends a portion of its life cycle in streams on the western Olympic Peninsula.

Riparian areas provide specialized habitat for many riparian-dependent plants in the OESF. At present, 32 species are classified by the state as threatened, sensitive, or in need of monitoring to track their status over time (Table 4.4.3). Table 4.4.3 includes 32 percent of the 65 listed taxa that occur below 4,922 feet elevation on the Olympic Peninsula (Houston et al. 1994). These statistics provide striking evidence that riparian areas within the proposed Experimental Forest support a high diversity of plant species and provide significant habitat for unique and dependent taxa.

4.4.2.2g Water-quality conditions

(1) Status of water quality

Table 4.4.4 lists streams in the OESF that currently are classified by the Washington Department of Ecology (1994) as water-quality-impaired. Washington State is delegated by the U.S. Environmental Protection Agency to administer federal water quality laws. In Washington State, water quality laws are administered primarily by the Washington Department of Ecology. This includes enforcing compliance by landowners to minimize nonpoint sources of water pollution (e.g. sediment from mass-wasting events) and avoid exceeding water-temperature and other water-quality criteria established in WAC 173-201A. This list of water-quality-limited streams is required by Section 303(d) of the federal Clean Water Act and has been approved by the Environmental Protection Agency.

The 303(d) list identifies 26 streams within the proposed Experimental Forest that exceed water temperature standards and one stream that exceeds fine sediment standards. Temperature exceedances generally are due to alteration of riparian canopy cover and changes in channel geometries (i.e., width-depth ratios) resulting from channel-bed erosion and aggradation. Additional concerns for listed streams include physical habitat parameters such as fine-sediment levels in spawning gravels, scour of spawning gravels, frequency and morphology of pools, and abundance of coarse woody debris (J. Schuett-Hames, Washington Department of Ecology Southwest Regional Office, Water Quality Program, Olympia, pers. commun., 1995).

The Department of Ecology is directed, through the Clean Water Act, to establish total maximum daily loads (TMDL) for all waters on the 303(d) list. The total maximum daily load is defined as the sum of all pollutant loads allocated to point and nonpoint sources within a watershed. The TMDL is set such that the loading capacity of an identified water segment is not exceeded. The agency distinguishes priority waters for TMDL development by assessing "vulnerability to degradation, extent of beneficial use impairment, availability to technical support, amenability to control the problem through TMDLs, and the degree of public interest." (Washington Department of Ecology 1994). Watersheds are managed on a 5-year cycle, during which time the intent is to meet water-quality standards through monitoring, watershed analyses, inspections, TMDL development, permitting, and other pollution-control activities. DNR and the Department of Ecology currently are pursuing the possibility of satisfying TMDL requirements with the Washington Forest Practices Board watershed-analysis process and prescriptions (WFPB 1995b), in order to work toward delisting of water-quality-limited streams (J. Schuett-Hames, Washington Department of Ecology Southwest Regional Office, Water Quality Program, Olympia, pers. commun., 1995; S. Bernath, DNR Forest Practices Division, Olympia, pers. commun., 1995). This cooperative agreement is contingent on the inclusion of water-quality and monitoring modules in the Washington Forest Practices Board watershed analysis manual, as well as a more comprehensive treatment of Type 4 and Type 5 drainages as nonpoint sources for stream sediment loading and water-temperature impacts. Due to the extent of 303(d) listings in the OESF, this area currently is under consideration as a priority for TMDL development (J. Schuett-Hames, Washington Department of Ecology Southwest Regional Office, Water Quality Program, Olympia, pers. commun., 1995).

(2) Water-quality conditions: Sedimentation
Management-related sedimentation of streams associated with landslides and debris flows, as discussed in Section 4.4.2.2b, has contributed substantially to the widening and shallowing of some channels on the OESF (e.g., McHenry et al. 1995; DNR 1995c). These changes in channel morphology, in turn, have led to declines in water quality. Channel aggradation not only jeopardizes the quality, quantity, and distribution of fish-spawning and macroinvertebrate habitat, but also influences seasonal water temperatures. Aggradation typically reduces channel depth and increases channel width, thereby increasing the water surface area exposed to solar radiation. Survival of aquatic organisms, especially cold-water fish such as trout and salmonids, is dependent on maintaining water temperatures below their thresholds of tolerance (Brown 1974). Large amounts of fine sediments deposited in stream gravels can eliminate essential habitat for aquatic organisms, bury food sources and spawning sites, and smother bottom-dwelling organisms (Bisson et al. 1992).

(3) Water-quality conditions: Temperature
Changes in water temperature of streams and associated water bodies also can result from removal of riparian vegetation through harvest and herbicide applications (Brown 1969; Timber/Fish/Wildlife Temperature Work Group 1990). Increases in mean daily water temperatures during the summer can be dramatic in smaller (i.e., lower-order) streams, thereby reducing habitat viability for salmonids and other riparian-dependent species (Brown 1972; Megahan 1980; Curtis et al. 1990).

Temperature data have not been collected from all stream segments in the OESF. Existing studies on greater than 50 percent of the 303(d) listed streams in the OESF suggest, however, that there is a strong relationship between canopy cover and stream temperatures. In a comparative study of managed and unmanaged watersheds in the Hoh and Bogachiel River basins, which include 54 percent of the 303(d) listed streams, Hatten and Conrad (1995) concluded that the proportion of a watershed occupied by late seral-stage forest (i.e., riparian and upland forests combined) correlated more closely with water-temperature regimes than with any other independent variable (e.g., basin area, elevation, channel gradient, channel dimensions and reach lengths). They found that maximum temperatures in streams draining managed tributary basins exceeded the state water-quality standard of 16.0 degrees C (60.8 degrees F) (WAC 173-201A; Washington Department of Ecology 1994) 10 times more often, on average, during the study period than streams draining unmanaged basins with late seral-stage forest cover. These findings are consistent with those of J. Schuett-Hames (see McHenry et al. 1995) for the Deep Creek watershed in the northern part of the OESF. Consequently, it is reasonable to suggest that such relationships between forest cover and water-temperature regimes exist in other drainages on the proposed Experimental Forest.

Composition of riparian forests also affects stream temperatures. Deciduous trees can provide enough shade to moderate summer water temperatures. During the winter, however, deciduous trees lose their leaves, which results in reduced stream insulation associated with the loss of canopy cover and wide fluctuations in water temperature

(Hatten and Conrad 1995). Conifer canopies, in contrast, provide shade and insulation year-round. The inability of deciduous canopies to moderate stream temperatures during winter poses a significant concern on the proposed Experimental Forest because of the predominance of red alder and young conifers in riparian stands. Analyses of the relationships between forest composition and stream temperature have not been performed everywhere on the OESF. However, a recent analysis of riparian vegetation in the 46,000-acre Hoko River watershed, for example, indicates that 93 percent of the streamside forests have been converted from conifer- to alder-dominated stands since 1940 (Pentec Environmental 1995). The Little Hoko River, part of the Hoko watershed administrative unit (WAU), is one of the 26 streams identified by the Washington Department of Ecology as exceeding state water-temperature threshold criteria.

Past harvest practices in riparian corridors on the OESF have resulted in streams with insufficient canopy cover. Historic and current practices detrimental to water temperatures include: (1) removal of all trees to the stream edge; (2) inadequate buffer widths; (3) ineffective buffer placement, resulting in buffer loss by windthrow or other disturbances; and, (4) conversion of conifer-dominated riparian stands to hardwood.

(4) Water-quality conditions: Water quantity

Relatively little is known about the relationships between forest harvest and water quantity on the western Olympic Peninsula. In fact, relationships between timber harvest and changes in watershed hydrologic regimes are some of the least understood processes occurring in managed landscapes. Studies elsewhere in the Pacific Northwest have indicated that increased surface runoff can result from changes in water transpiration, interception, evaporation, and infiltration rates associated with the removal of vegetation (see Section 4.1.4.6). The amount, spacing, and frequency of vegetation removal influence these hydrologic processes. Coffin and Harr (1992), for example, have shown in the western Cascade Range that clearcuts, partial cuts, and mature forest stands differ in their ability to absorb, retain, and disperse precipitation. In addition, roads have a considerable impact on the volume and timing of water delivery to streams (see Section 4.4.2.2c).

Currently, DNR's Olympic Region addresses water quantity issues via the Washington Forest Practices Board (1995) regulations. The state regulatory process for managing cumulative hydrologic effects of timber harvest (see hydrologic change module, WFPB 1995b) remains largely hypothetical and has not been tested over a sufficient length of time to yield statistically valid results. This theoretical process ascribes "hydrologic maturity" to the percent forest area in Type 3 basins with greater than 70 percent forest-crown closure and less than 75 percent hardwood or shrub canopies. Likewise, the influences of timber harvest on watershed hydrologic processes in the OESF have not been documented or studied thoroughly, although rain-on-snow events appear to be considerably less important than recurring long-duration, high-intensity rainstorms in governing peak-flow discharges on the OESF (S. C. Shaw, DNR Olympic Region, Forks, WA, unpubl. data, 1993).

4.4.2.2h Nutrient productivity

Little information exists, in the OESF or elsewhere in the Pacific Northwest, relating the probability of nutrient delivery to streams and the distance from the nutrient source to the active channel margin. While relatively more is known about nutrient sources and the role of various detrital nutrients in the riparian system (see Section 4.1.4.4), few studies have been conducted that demonstrate the pathways and time scales over which nutrients are transported to aquatic habitat. Based on available research, the Forest Ecosystem Management Assessment Team (1993) suggested that input of plant litter and other organic particulates from streamside forests decreases beyond a distance of about one-half of a site potential tree height from the channel margin. Newbold et al. (1980) have suggested that the diversity of aquatic insect communities, which depend on nutrient productivity for their survival, is highest in streams with riparian buffer widths of approximately 100 feet.

Current nutrient productivity of streams on the Experimental Forest is unknown. Several studies of macroinvertebrate populations in the western and northern parts of the OESF (McHenry 1991; McHenry et al. 1994) indicate that community richness has declined, which could be attributed to loss of habitat, decreases in available nutrients, or both. Predominance of hardwoods in many riparian stands might also affect the nutrient balance, as well as the type of detrital input on a seasonal basis (Bilby and Bisson 1992). Furthermore, several studies (Trotter 1995; Bilby et al. in press) in the western Pacific Northwest suggest that declines in coho populations in many coastal watersheds may be linked with significant losses in trophic productivity and nutrient transport downstream of reaches in which salmon spawn and die. Understanding of nutrient production and cycling on the OESF, however, is largely speculative.

4.4.2.2i Cumulative effects - Description of Contributing Actions and Ownerships

Terminology. Cumulative effects with respect to riparian and aquatic environments are those impacts on the riparian and aquatic system that result from the effects of the present action added to the impacts of other past, present, or reasonably foreseeable future activities across all land ownerships. This section does not address physical or biological impacts that are not directly or indirectly associated with riparian systems or their habitat functions.

Other ownerships: Ongoing/expected activities and their anticipated effects. DNR-managed lands comprise approximately 21 percent of the land base lying within the boundaries of the OESF (see Map 4). Federal lands managed by Olympic National Park and Olympic National Forest occupy roughly 36 percent of the land base. An additional 39 percent comprise private industrial forest lands and Indian tribal lands. Less than 5 percent are private, non-industrial forest lands.

Lands within Olympic National Park are managed, and will be managed for the foreseeable future, as wilderness for conservation and recreational purposes. Cumulative effects on riparian systems resulting from park management are relatively minimal. Park lands adjacent to or within the OESF contain few roads and no commercial resource-extraction enterprises that would disturb physical or biological functions and processes. River systems on the OESF have evolved with natural disturbance regimes characteristic of park lands, which include landslides, debris flows, water turbidity associated with upstream glacial sediment input, fires, blowdown, and forest-disease outbreaks.

Relatively high natural background sedimentation rates, therefore, are an important aspect of the OESF.

Lands within Olympic National Forest have been managed principally for timber extraction, resulting in similar types and rates of resource impacts as observed on DNR-managed lands (see Sections 4.4.2.2b and 4.4.2.2c). A greater percentage (i.e., about 55 percent) of USDA lands support mature second-growth and late-successional riparian forests than on DNR-managed lands, which could indicate that aquatic-resource conditions have not been compromised as much in these areas. However, rates of landsliding and road densities are roughly the same on USDA- and DNR-managed lands, suggesting that cumulative impacts to riparian systems might be within the same order of magnitude. The USFS expects that resources will be better maintained, protected, and restored with the upcoming implementation of the President's Forest Plan. An evaluation of cumulative effects and implications of the President's Forest Plan are provided in the plan's draft supplemental environmental impact statement (USDA and USDI 1993). Most of the USDA-managed lands are classified as Late-Successional Reserves. These areas might expect few additional impacts associated with timber harvest and road building, since these activities would be limited or restricted under the President's Forest Plan once it is adopted; however, many riparian systems will continue to respond to past activities that have left a legacy of mass wasting and road failures (e.g., see O'Connor and Cundy 1993; McHenry et al. 1995; USDA and DNR 1995).

Indian reservation and private commercial lands have been intensively managed for timber production. Little to no late-successional riparian forests exist on private timberlands and relatively little exists on reservation lands (J. Hatten, Hoh Tribe, Forks, WA, pers. commun., 1993; E. Currence, Makah Tribe, Neah Bay, WA, pers. commun., 1994; B. Naughton, Quileute Tribe, LaPush, WA, pers. commun., 1994). Riparian protection has varied on private timberlands from no buffer or other means of riparian conservation, prior to Washington Forest Practices riparian regulations, to limited protection under the current rule minimums (WFPB 1995c). Indian reservation timberlands have received little to minimal riparian protection, typically lower than or comparable to Washington Forest Practices Rules minimums. Information on future management of tribal lands is not available. Riparian conservation on private timberlands probably will continue to be implemented by Washington Forest Practices Rules minimums. In February 1996, the Washington Forest Practices Board adopted a new riparian function module (WFPB 1996) that will replace the one currently found in the watershed analysis manual (WFPB 1995b). This version potentially strengthens protection for coarse-woody-debris and shade sources by increasing the minimum assessment zone widths for debris recruitment in western Washington from 66 to 100 feet. Therefore, observed depletions in long-term sources of woody debris within 100 feet of the channel margin might require additional prescriptions for protecting wood sources. The module assessment also requires that all channels with gradients less than 20 percent be analyzed; this designation typically includes Type 4 and some Type 5 Waters. In addition, channel migration zones (CMZs) will also be evaluated in order to assess the potential for channel meander to affect the ability of existing and future riparian stands to provide long-term sources of coarse woody debris and shade.

Managing according to forest practices regulations includes the following current and anticipated effects. It is expected that water quality would be improved somewhat in the long term, via wider buffers and greater regulation of EPA water-quality regulations (see draft water quality module, WFPB in prep.). However, temperature and sedimentation will continue to be a problem because of the legacy of past disturbances (e.g., chronic landsliding, aggraded channels, decreased shade potential). Blowdown will persist until solutions are found to reduce windthrow potential; private and federal landowners are stymied by the same lack of information and programmatic approach to addressing windthrow that has reduced the ability of DNR to find successful solutions. New forest practices guidelines for assessing riparian functions are expected to result in improved protection of stream shade and debris recruitment, although full protection cannot be guaranteed because: (1) buffer widths in each WAU ultimately are set by a prescription team, who may or may not select as a standard the 100-feet width minimum used during the scientific assessment of coarse-woody-debris recruitment potential; and, (2) most buffers have not been tested or monitored long enough (i.e., several decades) to determine their long-term success. Hydrologic change associated with forest harvest in the rain-dominated precipitation zone, which encompasses most of the proposed Experimental Forest, will continue to be problematic because relatively little data exist to guide management and the Washington Forest Practices Board watershed analysis manual (WFPB 1995b) does not address this issue. In addition, roads will remain a major problem because there are no mechanisms for developing inter-party road plans necessary for minimizing the number of duplicated roads on adjacent ownerships. The high density of road networks across all land ownerships will continue to present problems for routine and effective road maintenance and abandonment, until all landowners adopt comprehensive road plans. There currently is a mechanism for requiring such plans today; WAC 222-24-050(1) requires DNR to use this authority to prevent road-related damage to fish, water, and capital improvements. This regulation, however, is not invoked on a routine basis. Road plans often are required only after significant material damage has occurred. DNR currently is conducting road-maintenance and abandonment training, to update landowners and operators on current road-construction and maintenance standards.

Ability of DNR to influence cumulative effects. Although DNR manages only about one-fifth of the land within the area designated as the Olympic Experimental State Forest, the department directly influences the nature and degree of cumulative impacts to aquatic and riparian habitat in many of the major OESF watersheds, through its proprietary (i.e., state trust lands) and regulatory (i.e., state and private lands) programs. Land ownerships are situated such that national park and national forest lands occupy the headwaters and upper reaches of many main river systems (i.e., Queets, Hoh, Bogachiel, Sol Duc, Calawah, Deep, Twin). Others, including the Clearwater, Solleks, Kalaloch, Mosquito, Goodman, and Clallam Rivers, are mostly or entirely situated in the large blocks of DNR trust lands. The remaining (i.e., Quillayute, Dickey, Ozette and other tributaries to Ozette Lake, Sekiu, Hoko, Pysht) rivers lie almost entirely on private industrial timberlands.

DNR has the greatest control over basinwide management practices in the large blocks of state-managed land, particularly where they adjoin federal ownerships. Federal acreage adjacent to state trust lands primarily are managed as wilderness (Olympic National Park) and Late-Successional Reserves (Olympic National Forest). Roughly 58 percent of the

776-km^2 (299 mi^2) Hoh River drainage area, for example, is administered by the national park for wilderness resource protection and recreation. DNR manages more than one-half of the remaining drainage area in the mid-section of the Hoh River basin, which coincides with some of the principal salmonid spawning and rearing habitat in this system. Hence, the department can exert considerable control over riparian and aquatic habitat viability by reducing cumulative impacts of forest practices on these lands, in addition to other watersheds primarily occupied by DNR-managed lands.

DNR has the least control over the lower portions of most river systems on the western Olympic Peninsula. These areas lie primarily in private timberlands along the coastal plain, on Indian tribal lands (i.e., Queets, Hoh, Quileute, Ozette, Makah Reservations), or within the wilderness coast strip of Olympic National Park.

Approximately 33 percent of DNR-managed lands comprise single legal sections (e.g., sections 16 and 36) that are scattered and isolated within a matrix of private and national forest lands. The department only administers a few square miles within the Bogachiel, Quillayute, Sol Duc, Dickey, Ozette, Sekiu, Hoko, Pysht, Deep, and Twin Creek drainages. Hence, the ability of DNR to influence the degree of cumulative effects in these basins is greatly diminished. Interior-core riparian buffers on state-managed land, for example, may prove to be ineffective in moderating adverse cumulative impacts to salmonid habitat when these buffers only exist on a few miles of a 60-mile long river.

Current conditions. Current riparian conditions in areas harvested prior to the enactment of 1993 Washington Forest Practices Rules reflect the minimal protection previously afforded to streams and streamside forests. In most cases, although not all, land managers followed the rules of the time and placed small (i.e., typically less than 25-foot wide) buffers to no buffers on streams. In addition, a high percentage of these thin, exposed buffers have long since blown down. Consequently, many of the immature riparian stands (e.g., less than 35 years old) on private and DNR-managed lands currently are depleted of large conifer trees as long-term sources of coarse woody debris, stream shade, robust forest structure, and stand compositional diversity.

Cumulative impacts of past management practices in all commercial timberlands on the western Olympic Peninsula have degraded aquatic and riparian habitat significantly. Past practices have left a legacy of long-term resource impacts that have contributed measurably to current watershed conditions, such as high rates of landsliding and road failures. Recent watershed assessments performed in several major river basins on the OESF (e.g., Hoh, Sol Duc, Calawah, Clallam, Pysht, Deep) indicate that past harvest and road-building practices, although acceptable at the time, typically have resulted in mass wasting, channel-bank instability, loss of coarse-woody-debris sources, conversion of conifer-dominated riparian forests to deciduous-dominated, and high road-network densities. These practices are described in Sections 4.4.2.2b and 4.4.2.2c as they relate to resource impacts. They include sidecast road construction, use of stream channels as roads and yarding or splash-damming conduits, tree harvest to stream edges, stream cleaning of organic debris, heavy broadcast burning that destroyed or degraded organic soil layers, no constraints on road locations or densities, and loss of side-channel, flood-plain, and wetland habitats.

Such disturbances are common to most land ownerships because such harvest and road-building practices were standard for the era (pre-1980s) and often were carried out by the same contractors. For example, many of the roads were built by the same contractors during the same period of time on private, state-managed, and USFS lands in the Sol Duc, Calawah, Bogachiel, Queets, Clallam, and Pysht drainages. Hence, the same type and frequency of road and landing failures, as described for state-managed land in Sections 4.4.2.2(b) and (c), have occurred on private and federal holdings (e.g., M. Erickson, USFS Sol Duc District, Forks, WA, pers. commun., 1994; P. Waldrip, Rayonier Timberlands, Forks, WA, pers. commun., 1994). Timber contracts were won by the same assemblage of purchasers on private, state, and federal lands during the 1960s-1980s, resulting in similar styles of harvest disturbance to riparian forests and stream habitat. In addition, private lands previously managed by one timber company are now split between several independent companies who must deal with similar disturbance regimes created by the original landowner. For example, much of the private land in the northwestern part of the OESF was owned during the mid-1900s by Crown Zellerbach Timber Company; several decades later, this area is now owned by a number of timber companies, including (Cavenham) Hanson Natural Resources Company, Green Crow, and Rayonier Timberlands. Along the Strait of Juan de Fuca, private and state land managers alike are dealing with intensive aquatic and riparian degradation that occurred as a result of widespread railroad logging around the turn of the century.

Hence, private, state, and federal forest managers have inherited a similar set of riparian habitat conditions and concerns throughout the OESF, including streams devoid of coarse woody debris, extensive channel-bank instability and flood-plain alteration associated with heavy-equipment operation in channels, and wholesale conversions of watershed riparian forests to alder and shrubs. As a result, most stream channels on the OESF have similar histories with respect to cumulative effects, although present management strategies for addressing long-term problems have differed by ownership.

In-stream restoration projects, including cooperative efforts between several landowners and agencies, have been undertaken on private, state, and federal lands to address cumulative impacts to fish habitat. These projects, however, have been limited in scope and size relative to the extensive demand for restoration across all land ownerships. Ongoing restoration projects include: (1) COHO project (WDFW, DNR, Hoh Tribe, and others); (2) Deep Creek restoration project (Lower Elwha S'Klallam Tribe, USFS, Merrill & Ring Timber Company, Rayonier Timberlands, DNR); (3) Sol Duc - Calawah watershed restoration (USFS Sol Duc District); and, (4) various other projects, including extensive road-sidecast pullback efforts (DNR Olympic Region; USFS Sol Duc District; Rayonier Timberlands). Efforts to secure additional funding for restoration projects, including cooperative ventures, continue with several recently submitted proposals to internal and external funding sources.

Estuaries and nearshore continental shelf. The OESF has few well-developed estuaries, other than those found at the mouths of the Quillayute and Pysht Rivers. Estuaries are geographically limited and small in size because the continental shelf is narrow and relatively steep near the land margin; in addition, most coastal valleys are narrow, thereby limiting the lateral extent of estuarine environments. Although little research has been done on estuarine conditions in the OESF, past and present dredging activities suggest that they are sensitive to sediment input and have been altered measurably by mitigation practices. Whereas both the Quillayute and Pysht River mouths were used as ports for ocean-going ferries and barges around the turn of the century, they currently are too shallow to allow passage of more than light recreational boats due to the aggradation of sediments transported from upstream reaches. Old docks in the town of Mora (Quillayute estuary) are now stranded from the current waterline by infilled channels and channel bars; furthermore, the river bed is highly aggraded for approximately 3 river miles upstream of Mora. Chronic sedimentation of the lower Quillayute River system has required extensive dredging in order to maintain a harbor for the town of LaPush. In addition, the mouth of the Quillayute River has been shifted permanently to the south by a rock jetty to confine the river mouth and create a deeper harbor.

Estuaries and the nearshore continental shelf are temporary storage areas for sediment delivered downstream by rivers, prior to sediment transport offshore by marine currents. It is reasonable to assume that the documented increases in sediment delivery rates on private, state, and federal lands upstream (see Section 4.4.2.2b), when combined, would increase the susceptibility of estuaries to sedimentation and associated habitat degradation. Although little data have been published on Olympic Peninsula estuaries, the extensive aggradation of the Quillayute River and evidence of sediment burial of algal beds in the LaPush (Quillayute) harbor (A. Shaffer, Quileute Fisheries, LaPush, WA, pers. commun., 1994), as well as previous sedimentation and dredging of the Pysht estuary, suggest that cumulative effects of sedimentation, both in time and space, are a significant concern in the proposed Experimental Forest. Accelerated rates of channel sedimentation result in greater rates of sediment deposition in near-shore marine environments. Consequently, reducing sediment delivery to streams from upland sources would reduce the need for channel dredging and vulnerability of estuarine habitats to sedimentation.

Additional relevant information. A desired outcome of the Olympic Experimental State Forest plan is to maintain and enhance habitat on lands administered by the department and to foster partnerships with adjacent landowners in forestwide efforts to protect and restore aquatic and riparian resources. DNR does not intend that landowner partnerships be considered as part of the HCP agreement with USFWS. Rather, partnerships are viewed as part of achieving the overall mission of the OESF, and this information is included to aid the development of agency procedures for the OESF. DNR recognizes that many cumulative-effects issues can only be addressed through cooperative efforts with adjacent landowners, particularly where DNR-managed land comprises a small fraction of the watershed land base. Partnerships are expected to result in greater awareness of basinwide cumulative effects, pooled efforts to understand and minimize additional impacts, and interagency restoration projects. It is expected that experimentation across ownership boundaries will contribute toward better understanding of cumulative effects and the complex interactions between physical, biological, and anthropogenic factors. The Olympic Peninsula represents a unique laboratory for studying cumulative effects because wilderness and reserve lands adjacent to the OESF in Olympic National Park and Olympic National Forest not only offer control sites for experiments but also provide rare opportunities for paired studies and comparative research in unmanaged and managed landscapes.

4.4.2.3 Evaluation of Proposed Alternatives in the OESF -- Riparian Habitat

In the following discussion, OESF Alternative 1 corresponds to the No Action alternative (i.e., current practices). The Unzoned Forest alternative is OESF Alternative 2, and the Zoned Forest alternative is OESF Alternative 3. The riparian conservation strategies for Alternatives 2 and 3 are identical. Hence, the types and levels of impact associated with management or conservation activities carried out under either alternative are expected to be the same for most riparian habitat components. Where differences occur between Alternatives 2 and 3, the types and levels of impact are discussed explicitly.

4.4.2.3a Mass wasting and channel-bank instability

The level of protection for mass-wasting sites (e.g., landslides, channel-bank collapse) in the OESF potentially is the same or greater for the Unzoned Forest and Zoned Forest alternatives than the No Action alternative. All alternatives establish interior-core riparian buffers that would be managed similarly to minimize mass-wasting processes and reduce the likelihood of sediments entering stream channels via landslides, debris flows, channel-bank erosion, and other forms of mass movement. The OESF action alternatives, however, provide a greater assurance that these interior-core buffers will remain intact by buffering the interior core with an exterior buffer, where necessary, to reduce the likelihood of windthrow and other catastrophic or chronic disturbances to streams and streamside forests.

ALTERNATIVE 1

The No Action alternative provides a moderate to moderately high level of protection for mass-wasting sites. This alternative currently offers a moderate level of protection in the OESF because it has not been applied consistently across all DNR-managed lands. Today, roughly 55 percent of riparian areas are protected by actively managed buffers that have average widths comparable to the interior-core buffers described in Section 4.4.2.2b (see Table 4.4.5), whereas the remaining 45 percent are afforded protection that meets or minimally exceeds current Washington Forest Practices Rules for Riparian Management Zones (RMZs) (WAC 222-30-020(3); WFPB 1995c). Present riparian-buffer strategies are inadequate in cases where buffers established according to forest practices rules have failed to minimize mass-wasting disturbances or supply sufficient sources of coarse woody debris to the channel.

DNR intends to apply interior-core riparian buffers consistently across all DNR-managed land on the OESF, in order to implement fully the departmental policies set forth in the Forest Resource Plan (1992). The Olympic Region expects that it will take another several years to achieve this objective due to the volume of fieldwork required to establish buffers that meet on-the-ground conservation needs. Full implementation of these policies likely will result in a moderately high level of protection to riparian and aquatic systems from mass-wasting disturbances on the OESF. Nonetheless, DNR cannot guarantee that mass-wasting events related to forest management activities will be avoided, or that the No Action alternative will result in a high level of protection, because many channel margins and headwalls are still responding to harvest and road-building disturbances that occurred several decades ago (e.g., sidecast deposits that have not yet failed but potentially will collapse in the future). In addition, the success of buffers in preventing mass wasting often cannot be measured on time scales shorter than 10 to 20 years because it takes a relatively long period of time for root systems, which anchor soils to hillslopes, to decay (Ziemer 1981; Sidle et al. 1985). Hence, the level of certainty is reduced that all interior-core buffers will serve their intended purpose.

DNR does not intend to prevent natural hillslope and channel-margin failures, as such occurrences are vital to creating and maintaining downstream spawning and rearing habitats (e.g., Naiman et al. 1992). Hence, full implementation of the No Action alternative likely will result in a rate of mass wasting more characteristic of the natural disturbance regimes in which streams evolved on the western Olympic Peninsula. Reduction in artificially high sedimentation rates should decrease the likelihood of channel-bed scour, aggradation of streams and estuaries, and changes in channel morphology, thereby improving the quality and quantity of aquatic habitat.

ALTERNATIVE 2

Interior-core riparian buffers have proven inadequate in situations where blowdown continues to reduce the size of or eradicate buffers (see Section 4.4.2.2d). The Unzoned Forest alternative decreases this potential by expanding the width of the riparian buffer via an exterior buffer whose configuration will be designed to lower the probability of windthrow (see Figure 4.4.1). Hence, this alternative probably will result in similar levels of protection for unstable ground where windthrow is not an issue, and greater levels of protection where exterior buffers are established to moderate windthrow potential, than the No Action alternative.

Under this alternative, long-term monitoring and research in riparian systems are expected to improve understanding of mass-wasting processes in DNR-managed landscapes, such that management strategies can be modified and strengthened over time. A structured research and monitoring program is not offered under the No Action alternative.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3a.

4.4.2.3b Windthrow

The Unzoned Forest and Zoned Forest alternatives potentially provide more protection to windthrow-prone riparian areas than the No Action alternative because the addition of an exterior buffer expands the overall width of the riparian buffer, thereby increasing the distance between the stream and the edge of the riparian buffer. Where it has been determined with certainty, via simulation modeling or field data, that windthrow is not an issue, the No Action and two OESF action alternatives would be implemented similarly (i.e., no established exterior buffer) and provide the same levels of riparian protection.

ALTERNATIVE 1

The No Action alternative provides a variable amount of protection from wind disturbances to streamside forests, which ranges from adequate to inadequate depending on local site characteristics. Current evidence suggests that buffers comparable to the interior-core buffers have been diminished or eradicated by successive windstorms in some exposed valley bottoms. Hence, the ability of these buffers to remain intact and upright can be jeopardized, thereby decreasing the likelihood of interior-core buffers to supply continuous sources of coarse woody debris, stream shade, bank stability, and other key functional elements. Where the probability of windthrow is lower and the interior-core buffers are sufficiently wide to withstand windstorms, the No Action alternative provides a relatively high level of protection to streams and streamside forests. With few data and little understanding of windthrow processes to guide management strategies, however, the success of various riparian-buffer configurations in reducing windthrow is hard to predict.

ALTERNATIVE 2

The exterior buffers of the Unzoned Forest alternative (Figure 4.4.1) expand the width of the interior-core buffers (see Table 4.4.6), thus conceivably increasing the protection of streamside buffers from edge effects associated with wind disturbance and upland management practices. The ability of exterior buffers to protect the integrity of interior-core buffers along each stream reach of interest, however, is confounded by the fact that little quantitative information or management guidance currently exists for how and when to establish such buffers. On the western Olympic Peninsula, DNR is faced with a limited pool of knowledge concerning forestry-windthrow interactions and a highly fragmented forest in which the remaining stands (i.e., 30 percent of the forest base) are susceptible to edge effects. Hence, the purpose of the experimentation program for designing exterior riparian buffers is to explore new methods and approaches for creating and maintaining windfirm streamside forests. This research and monitoring program would benefit not only riparian conservation and management in the OESF but also, hopefully, an understanding of riparian processes and management needs in west-side forests of the Pacific Northwest.

Some risk to maintaining the integrity of interior-core buffers in mature stands will be incurred as a result of manipulative research and experimentation in exterior buffers. It is expected, however, that wind susceptibility will be no greater in experimental exterior buffers placed in mature forests than currently is the case in interior-core riparian forests with no additional exterior buffer.

The Unzoned Forest alternative should yield a greater likelihood for long-term protection of riparian forests than the No Action alternative because it incorporates a strategy for enhancing the future conditions of these streamside areas. Approximately 70 percent of riparian stands are young plantations less than 30 years old or are primarily deciduous. Under the Unzoned Forest alternative, management strategies include manipulating stands to generate windfirm, robust trees capable of moderating edge effects, as well as restoring compositional and structural forest diversity.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3b.

Additional relevant background information for the OESF

The Unzoned Forest and Zoned Forest alternatives employ exterior buffers according to stream type, average widths of which were estimated by qualitatively evaluating historic patterns of windthrow resulting from average winter storms on the OESF (see Section 4.4.2.2d) and by reviewing local wind-buffer trials. These average widths are regarded as starting hypotheses pending the outcome of windthrow experiments on the OESF. This experimental program is designed to test different methods for protecting riparian buffers from wind and upland disturbances. The experimental program will require research, experimental harvest designs, and long-term monitoring.

Experimentation would occur in some, but not all, exterior riparian buffers. The goal of these experiments would be to determine successful methods for protecting the integrity of interior-core buffers, which then could be extrapolated to sites with similar features (e.g., topographic relief, stand characteristics, prevailing wind directions). Stand manipulation in exterior buffers might range from complete to partial to no harvest, in a variety of tree spacing and stand geometric configurations. Complete harvest at a particular site would occur only where meteorological data, modeling, or other documentation indicate that windthrow does not occur. Experimental stand manipulations would be carried out simultaneously with management activities in upland areas to minimize disturbances and increase ecological compatibility (i.e., reduce the number of abrupt, wind-prone stand edges). Light partial harvest, with maximum tree removal of 33 percent by volume, would occur in exterior buffers not included in the experimental program. Subsequent removals of 33 percent by volume would only occur provided the remaining 66 percent comprised mature, windfirm, compositionally and structurally diverse forest stands. This means that an additional 33 percent by volume may not be removed, following the initial harvest, until that 33 percent has been replaced by mature trees that are capable of meeting criteria for windfirmness, shade, coarse-woody-debris recruitment, etc. (i.e., harvest once every rotation in adjacent upland stands). This interim measure would be in effect until experimental results could be applied confidently to all portions of the OESF.

4.4.2.3c Coarse (large) woody debris

The No Action, Unzoned Forest, and Zoned Forest alternatives potentially provide a similar level of protection to source areas for long-term recruitment of coarse woody debris to stream channels (see Figure 4.4.1) via the interior-core buffers. The Unzoned Forest and Zoned Forest alternatives would supply greater sources of coarse woody debris to the riparian flood plain and forest floor than the No Action alternative.

ALTERNATIVE 1

The No Action alternative likely would result in retaining sufficient short- and long-term sources of coarse woody debris for streams in the OESF. The best present understanding of wood recruitment to streams in the western Pacific Northwest (e.g., McDade et al. 1990; Van Sickle and Gregory 1990) is that the majority of coarse woody debris originates within a distance of one site potential tree height of the active channel margin. A smaller percentage of wood is transported to a particular channel reach from landslides on adjacent hillslopes or from upstream via channel flows. In the absence of information specific to the OESF, DNR ascribes to this line of reasoning as a suitable starting hypothesis for future evaluation of recruitment processes.

Under this alternative, average interior-core buffer widths for each stream type established on the OESF are greater than, or approximately equal to, the site potential tree height for a 50-year growing cycle and 70- to 90-percent of the site potential tree height for a 120-year growing cycle. Table 4.4.7 compares interior-core buffer widths for each stream type with site potential tree heights for 50-, 100-, and 120-year growing periods. Representative site potential tree heights for each stream type were calculated for the OESF (R. E. Bigley, DNR, Olympia, pers. commun., 1995) by: (1) identifying streams of known type on soil-survey maps registered by orthophotos; (2) determining average site indices for growth potential from survey data for soils commonly encountered on stream banks and flood plains; (3) calibrating site indices to account for species-composition and elevational differences typically found between lower-elevation (e.g. Type 1-3) streams and higher-elevation (e.g., Type 4-5) streams; and, (4) employing tree-height tables compiled by Wiley (1978).

Riparian buffers under the No Action alternative are considered potentially adequate for long-term wood recruitment to streams, because the majority of riparian corridors in the OESF currently do not support large, old conifers but likely will do so in the future once adequate streamside buffers are established. Current management strategies, under the Forest Resource Plan (1992) should lead to replenished streamside forests. As described in Section 4.4.2.2e(2), past forest management practices have resulted in many riparian areas that contain few large conifer logs in stream channels and minimal potential for wood recruitment from young plantations or alder-dominated stands. Full implementation of the No Action alternative across the proposed Experimental Forest should promote regeneration of big conifers in streamside forests, which would restore coarse-woody-debris recruitment potential to streams. In 70 percent of riparian areas in the OESF (i.e., young plantations), such restoration of big conifers might take much longer than 40 years. In the remaining 30 percent, which contain trees greater than about 70 years old, minimal timber extraction would result in greater retention of coarse-woody-debris sources.

The No Action alternative potentially provides a moderate to high amount of protection for long-term recruitment of coarse woody debris to the flood plain and riparian-forest floor. In low-gradient, alluvial channels on DNR-managed lands, the interior-core buffers will encompass the active flood plain (i.e., 100-year flood plain) but might or might not incorporate older flood-plain surfaces and the full extent of the riparian forest floor, depending on local topography. In higher-gradient, confined reaches, the interior-core buffers likely will incorporate flood plains and riparian forest floors in their entirety.

ALTERNATIVE 2

The Unzoned Forest alternative would result in similar levels of protection for short- and long-term recruitment of coarse woody debris to streams, via the interior-core buffers (see (1), Section 4.4.2.3c), compared to the No Action alternative The exterior buffer in the Unzoned Forest alternative, however, would expand the overall width of the protective riparian buffer to 100 percent, or greater, of the 120-year site-potential tree height in areas prone to windthrow (see Tables 4.4.6 and 4.4.7). The exterior buffer thus would increase the riparian area in which generation of large conifer trees, as potential sources of coarse woody debris, would occur. Timber harvest in the exterior buffer, which on average would be comparable to a light partial harvest (i.e., 33 percent removal by volume per rotation), should retain an adequate source of large conifer trees for eventual recruitment to the stream. In areas where hardwoods dominate riparian forests, efforts would be emphasized to manipulate stands such that a more natural balance of hardwood and conifer densities be achieved. Stand conversions would occur only where physically and ecologically feasible. Since the primary objective of the exterior buffer is to promote robust, windfirm trees that shield the interior-core buffer from external disturbances (e.g., wind, management activities on adjacent land), the retention of large dominant and co-dominant trees would be emphasized. Hence, this alternative also would provide a greater source area for long-term recruitment of coarse woody debris to the riparian-forest floor than the No Action alternative (see Figure 4.4.1). In addition, this alternative would yield greater source areas for recruitment of large downed logs on the flood plains. Flood-plain logs are critical for regulating flow velocities and sediment transport, and providing off-channel habitat for fish when riparian areas are flooded.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3c.

4.4.2.3d Water quality

As summarized in Section 4.4.2.2g, the principal causes of degraded water quality in the OESF are stream sedimentation and water temperatures exceeding state and federal water- quality standards. Streamside buffers presently are considered the best mechanism for moderating temperature and sedimentation problems in Washington (e.g., J. Schuett-Hames, Washington Department of Ecology Southwest Regional Office, Water Quality Program, Olympia, pers. commun., 1994), provided that buffers are wide enough to: (1) reduce the potential for sediment delivery over and above natural background sedimentation rates; (2) supply adequate shade to regulate water temperatures; and, (3) assure long-term sources of coarse woody debris that will regulate stream flow and sediment discharges (see Section 4.4.2.3c). Streamside buffers, however, need to be established in conjunction with other water-quality controls (e.g., road-maintenance plans, stand hydrologic maturity) to resolve sedimentation and water-temperature problems.

Pesticides and herbicides currently are not used in riparian areas on the OESF. It is expected that this regional policy would not be changed under the Unzoned Forest or Zoned Forest alternative.

4.4.2.3d(1) Water quality: Sedimentation and roads

The Unzoned Forest and Zoned Forest alternatives have a greater potential for regulating the frequency and volume of sediment delivery to streams than the No Action alternative. Stream sedimentation processes include mass wasting (see alternatives evaluation in Section 4.4.2.3a) and surface erosion from hillslopes and roads. Hillslope surface erosion is a minor factor on the western Olympic Peninsula, whereas road erosion is a dominant concern (see Section 4.4.2.2c).

ALTERNATIVE 1

The No Action alternative provides a moderate level of protection to streams from sedimentation associated with mass wasting (see (1), Section 4.4.2.3a) and road erosion. An unavoidable consequence of building roads, however, is that the hydrologic regime of the hillslope is altered permanently by removing substrate and constructing impervious surfaces to water infiltration. Roads on the OESF, therefore, will continue to impact the delivery of water and water-transported sediment to channels regardless of how well they are sited, constructed, maintained, and abandoned.

Currently, no consistent program exists for monitoring and tracking road-network conditions, other than through the recollections of unit foresters, notes on timber-sale proposals, road surveys performed approximately every 6 years, and annual requests for site repairs (e.g., culvert replacements, ditch cleanouts, landslide clearance). Major road construction and reconstruction generally are performed by the timber buyer, rather than the DNR road-maintenance crew. Road construction typically is considered by DNR on a harvest-unit basis, often without adequate evaluation of the impact of each road on the physical and biological conditions of the watershed as a whole, particularly with respect to increasing road densities. Each new road potentially adds an additional conduit for water and sediment delivery directly to stream channels, rather than through natural pathways (e.g., water percolation to the ground-water table) that create lags in the timing and volume of delivery (Harr et al. 1975, 1979; Harr and McCorison 1979; Jones and Grant in press). Roads effectively expand the stream-drainage density, in some cases by an order of magnitude, particularly during periods of high discharge (e.g., Grant 1986).

ALTERNATIVE 2

The Unzoned Forest alternative likely would provide a moderate to high level of protection to streams from mass wasting (see (2), Section 4.4.2.3a) and road erosion. Larger buffers (i.e., interior and exterior buffers combined) under this alternative would contribute substantially toward reduction of overland sediment runoff from surface-erosion sites (e.g., roads, yarding and skidder trails, ground-based harvest units) outside the riparian buffers, based on present understanding of the relationships between sediment-travel distance, vegetation density, and sediment-delivery potential (e.g. see Megahan and Kidd 1972; Reid and Dunne 1984; Burroughs and King 1989). Greater overland transport distances and vegetation density generally correspond to a decreased potential for sediment delivery to streams. In addition, comprehensive road-maintenance plans would provide greater assurance that surface-erosion and water-drainage problems associated with roads would be evaluated and corrected, such that the likelihood of sediment delivery to channels via overland transport and road drainages would be reduced. Furthermore, this alternative provides a strategy for minimizing new road construction via long-term landscape planning (described in the draft HCP).

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3d(1).

4.4.2.3d(2) Water quality: Temperature

The No Action, Unzoned Forest, and Zoned Forest alternatives potentially provide the same level of protection to stream temperatures, via forest-canopy shade supplied by interior-core riparian buffers, although the latter two alternatives may result in slightly greater protection via the application of an exterior-wind buffer. The intent of the outer buffer is to help reduce the potential for blowdown; windthrow often compromises the ability of the inner buffer to maintain windfirm stands that provide adequate stream shade. Stream water temperatures are regulated by the amount of canopy cover provided year-round and by the channel surface area exposed to solar radiation which is, in turn, affected by the channel width relative to its depth. Sediment aggradation is a principal cause of stream widening on the OESF and is being addressed via reductions in the frequency, volume, and timing of mass-wasting and surface-erosion events (see Section 4.4.2.3d(1)). Year-round canopy cover is important for insulating streams from summer heat and fluctuations in winter temperatures.

ALTERNATIVE 1

The interior-core buffers established by the No Action alternative potentially are wide enough to supply 80 to 100 percent of stream shade, provided that streamside canopies are dominated by mature conifers. This evaluation is based on a comparison with buffer widths recommended by several studies in the Pacific Northwest for meeting stream shade requirements (Steinblums 1977; Steinblums et al. 1984; Beschta et al. 1987). Riparian buffers are described as potentially wide enough to provide shade because many currently provide inadequate stream shade on a year-round basis. At least 70 percent of riparian forests on DNR-managed land are dominated by deciduous species or immature conifers. Hence, it might take from 20 to 100 years to regenerate conifer-dominated forests capable of supplying sufficient canopy cover to moderate stream water temperatures.

ALTERNATIVE 2

Similar to the No Action alternative, the interior-core buffers established by the Unzoned Forest alternative potentially are wide enough to supply 80 to 100 percent of stream shade, provided that streamside canopies are dominated by mature conifers. Under this alternative, proposed exterior buffers are expected to provide additional canopy cover in riparian areas offering less than 100 percent shade availability. There is little difference among the alternatives with regard to meeting water-temperature objectives although the Unzoned Forest alternative may provide slightly greater protection to the physical integrity of the interior-core buffer via the exterior wind buffer. Therefore, all alternatives are expected to permit regeneration of streamside forest canopies, over time, that will maintain stream temperatures within acceptable ranges for sustaining fish and macroinvertebrate populations.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3d(2).

4.4.2.3e Water quantity (stream flow)

Given the fact that the assumed relationships between timber harvest and watershed hydrologic regimes are largely hypothetical (see Section 4.4.2.2g(4)), discussions of the various alternatives with respect to their effect on water quantity are speculative. The potential for regulating the quantity and timing of surface runoff to streams in the OESF probably is relatively greater with the Unzoned Forest alternative than with the No Action or Zoned Forest alternatives. Regulating road-surface runoff and hydrologic functioning of watershed forests are primary issues in the No Action and two OESF action alternatives.

ALTERNATIVE 1

The No Action alternative probably has a relatively small chance of regulating road-drainage volumes because there are thousands of miles of active and inactive roads which, under current operating policies and costs, cannot be maintained adequately by DNR road crews. In addition, maintenance on a considerable proportion of roads on DNR-managed lands in the Experimental Forest is largely dependent on road-use contracts associated with individual timber sales, which means that road-drainage problems sometimes are not rectified in a timely fashion. Inactive or abandoned roads are not maintained on a routine basis. New roads are built without evaluations of the existing road densities and the potential for affecting peak and low stream flows with the addition of new ditchlines.

The No Action alternative similarly has a small probability of regulating water yields associated with timber harvest. The DNR state-lands program has no programmatic sponsorship of the Washington Forest Practices Board (1995) watershed analysis, which is the primary regulatory vehicle by which management-related changes in hydrologic regimes are detected and corrected. Hence, regulatory watershed analyses are not scheduled according to any time line and may not be initiated for years to decades. DNR's Olympic Region currently has no other methods for analyzing water-quantity processes and creating management strategies to address identified problems. Even though the forest practices methods have not been tested through application over time and the regulatory watershed analysis process may not be invoked in every watershed, the hydrology module developed for that process is the tool most likely to be used by the region during landscape planning when water quantity is an issue.

ALTERNATIVE 2

The Unzoned Forest alternative is expected to better regulate hydrologic maturity and road-drainage functions and densities than the No Action alternative. Under the Unzoned Forest alternative, silvicultural practices would include clearcuts and partial cuts. However, since its long-range intent is to disperse such practices, the Unzoned Forest alternative likely would reduce the discrepancies in average stand ages, structures, and compositions across the OESF. The working hypothesis is that clearcut patches would be fewer, smaller, more broadly spaced, and better integrated with partial-harvest units and habitat conservation areas than under the No Action or Zoned Forest alternatives. As a result, water yields possibly would be more adequately controlled than currently is the case, particularly in the many 500-acre or larger watersheds that have been harvested entirely during the last decade. In addition, comprehensive road-maintenance plans would assure routine monitoring and maintenance of road ditches and cross drains, as well as analyses of the effects of adding new roads to the transportation network.

The Unzoned Forest alternative would provide new knowledge of water issues in the proposed Experimental Forest. A priority research goal would be to gain a better understanding of hydrologic processes on the western Olympic Peninsula that would yield more sound, long-term approaches to managing water resources.

ALTERNATIVE 3

Comprehensive road-maintenance plans under the Zoned Forest alternative likely would reduce the potential for road-drainage problems, similar to the Unzoned Forest alternative. Experimentation and research would also improve understanding of hydrologic processes and impacts of forest management on water quantity. Conservation and management strategies, however, would tend to promote intensive harvest (i.e., clearcuts) in the uplands to compensate for restricted silvicultural opportunities in the habitat conservation areas. Concentrating intensive harvest in certain portions of the landscape likely would contribute toward measurable changes in the hydrologic regimes of those areas. Hence, this alternative would probably provide greater regulation of water volumes and discharge rates than would the No Action alternative, but less control than the Unzoned Forest alternative.

4.4.2.3f Nutrient productivity

ALTERNATIVE 1

Present understanding of nutrient cycling and the effects of forest management on nutrient budgets is limited. Based on the information supplied in Section 4.4.2.2h with regard to nutrient productivity, however, it appears that the No Action alternative would provide some level of detrital nutrients to stream channels via the interior-core buffers. This evaluation assumes that forests along the stream bank are primary sources of dissolved nutrients and organic detritus (e.g., woody debris, leaves, needles, insects) delivered directly to streams. Given that a complete understanding of nutrient cycles is lacking in managed and unmanaged landscapes, however, the long-term success of any action alternative in maintaining nutrient productivity is uncertain. It is expected that the No Action alternative would maintain nutrient input from sources proximal to stream banks because streamside forests would be managed to produce mature, compositionally and structurally diverse stands. In addition, small-order streams are protected with riparian buffers, which enhances their ability to generate and deliver nutrients to the watershed channel network.

ALTERNATIVE 2

The Unzoned Forest Alternative is expected to afford relatively the same level of protection to nutrient sources as the No Action alternative, via the interior-core buffers. The addition of exterior buffers might enhance the protection of nutrient sources, especially if wind or other externally generated disruptions of physical and biological processes in interior-core buffers is a factor. In addition, this alternative could improve nutrient productivity and delivery to streams because it incorporates a long-term strategy for enhancing the future biodiversity of riparian forests. Loss or degradation of interior-core buffers could have detrimental effects on nutrient productivity and cycling.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3f.

4.4.2.3g Microclimate

The ability of riparian buffers to moderate climatic conditions in the transitional areas between terrestrial and aquatic environments depends on their lateral and longitudinal extent relative to the scale of the watershed, as well as the proximity and intensity of natural and management-related edge effects. Few data are available from the western Olympic Peninsula, or elsewhere in the Pacific Northwest, pertaining to the effects of forest management on riparian microclimate conditions. Studies in upland forests (Chen et al. 1992, 1993) show, however, that patch size and configuration, orientation relative to prevailing wind directions, and stand ages, among other factors, influence key microclimate parameters. These parameters include relative humidity, light and wind penetration, and air and soil temperatures. It is assumed that these microclimate functions are important in riparian forests on the Experimental Forest as well.

ALTERNATIVE 1

The No Action alternative is expected to provide some of the key parameters controlling microclimate by eventually establishing mature, compositionally and structurally diverse riparian forests on most streams (i.e., approximately 94 percent) in the OESF. Wider buffers than employed in past decades, as well as establishing buffers where they did not exist previously, would contribute toward moderating air and water temperatures and relative humidities. Current buffers do not protect microclimate adequately in many instances. For example, establishing functional microclimate buffers on streams might take as much as 100 years in some areas where mature forests are nonexistent on one or either side of the channel. It is unknown how effective interior-core buffers might be in regulating microclimate; however, generating mature riparian buffers along most streams should improve future microclimate conditions over present ones.

ALTERNATIVE 2

A primary working hypothesis of the Unzoned Forest alternative is that riparian microclimate would be improved by placing dual buffers (i.e., interior-core and exterior) on both sides of streams, and by minimizing edge effects associated with land management activities adjacent to riparian buffers. The Unzoned Forest alternative provides wider buffers, with the interior and exterior buffers combined, than the No Action alternative. Hence, it is expected to provide better regulation of microclimate parameters than current practices. In addition, the experimental approach to designing exterior buffers in conjunction with adjacent harvest units, and rigorous research in exterior buffers, are expected to improve scientific and management understanding of microclimatic processes in riparian environments.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3g.

4.4.2.3h Riparian system functions

The Unzoned Forest and Zoned Forest alternatives potentially provide greater protection to combined physical and biological functions of riparian systems than the No Action alternative. Buffers applied under any alternative require adjustment on the ground to ensure adequate protection of physical and biological processes at each site. The methods for evaluating and adjusting buffer widths under the OESF action alternatives, however, ensure a more systematic and interdisciplinary analysis of conservation measures necessary to accommodate riparian functions and the complex interactions between physical and biological processes in riparian systems.

ALTERNATIVE 1

Under the No Action alternative, riparian buffers typically are established by applying the Washington Forest Practices (1995) Rules minimums for Forest Practices RMZs and then expanding these riparian zones to incorporate mass-wasting processes on a site-by-site basis (see discussion of average interior-core buffer widths, Section 4.4.2.2b). These evaluations generally do not analyze all known important physical and biological functions of riparian areas in any systematic fashion. Consequently, some buffers established on the basis of mass-wasting concerns might not provide adequate protection for other key riparian functions (e.g., debris inputs, microclimate regulation). In general, the No Action alternative is expected to provide some moderate level of protection for stream and stream-bank physical and biological processes in most cases. However, process interactions between the streamside and flood plain/riparian environments might not be incorporated by buffer protection in some instances.

ALTERNATIVE 2

The Unzoned Forest alternative provides a more systematic and scientifically rigorous method than the No Action alternative for evaluating riparian conservation needs to achieve successful protection of known key physical and biological functions and their interactions. The process for designing buffers under this alternative would involve applying standard buffer widths, as determined by the statistical analysis described in Sections 4.4.2.2b (interior-core buffers) and 4.4.2.3b(4) (exterior buffers), and adjusting them on the ground to meet site requirements. This process would provide greater assurance, than does the No Action alternative, that buffers would be sufficiently wide to accommodate an assemblage of functions and processes on a site-by-site basis, particularly where unstable channel margins and hillslopes are not a factor. Figures 4.4.4, 4.4.5, and 4.4.6 demonstrate one of several potential scenarios for adjusting buffer widths to accommodate site conditions. Figure 4.4.4 shows the application of interior-core and exterior buffer widths, as standard measures, to a segment of the Clallam River and its tributaries. Figure 4.4.5 compares these buffer widths with a riparian buffer designed solely to protect unstable channel banks and adjacent hillslopes; the latter was developed from a field-verified mass-wasting inventory of the area. Figure 4.4.6 shows one example of how standard buffer widths (i.e., Figure 4.4.4) could be adjusted to accommodate mass-wasting sites and wind protection on the ground. The resulting buffer in this scenario is the outermost line at any given site on Figure 4.4.5, as is represented in Figure 4.4.6. This figure shows one possible configuration that actually would be implemented to meet riparian conservation objectives for maintaining physical and ecological functions of the riparian system. Another possible configuration would involve adding the standard exterior (wind) buffer to an interior-core buffer designated on the basis of field-verified mass-wasting inventories (i.e., Figure 4.4.3 with an added exterior wind buffer). The ultimate buffer designation, however, likely would be some combination of these configurations, as determined via field analyses, that yielded adequate protection for mass-wasting sites, key physical and biological riparian functions, and riparian stands prone to windthrow.

The Unzoned Forest alternative also provides an avenue for gaining better knowledge of the complex interactions between physical and biological processes in riparian environments. Research and long-term monitoring are expected to yield information that would contribute toward improved scientific and management understanding of riparian systems.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3h.

4.4.2.3i Cumulative effects

Section 4.4.2.2i describes current conditions, present and expected actions, and anticipated effects of such actions with respect to cumulative impacts across all land ownerships on the western Olympic Peninsula.

ALTERNATIVE 1

The No Action alternative provides greater protection to riparian resources and likely has a greater potential for reducing cumulative impacts of forest practices than do current practices on other nonfederal forest lands, which typically meet or fall below Washington Forest Practices Rules minimums (see Section 4.4.2.2i). Future management plans of private and tribal landowners are not known to DNR; it is unknown whether other nonfederal landowners will develop HCPs for their lands or deviate substantially from management via forest practices rules minimums. The No Action alternative probably provides less protection to riparian resources and potential cumulative impacts of forest practices than does the President's Forest Plan for Late-Successional Reserves in Olympic National Forest because riparian buffer widths are smaller and relatively more timber volume will be removed from DNR-managed riparian forests.

Current degraded aquatic and riparian habitat throughout managed lands on the OESF suggest that private, state, tribal, and federal entities have not provided adequate riparian protection in the past. The No Action alternative, President's Forest Plan, and new Washington forest practices assessment guidelines for riparian functions (WFPB 1996), as well as new regulations that could be formulated from these guidelines, will contribute measurably toward long-term reduction in cumulative impacts. In the short term (e.g., next several decades), however, stream and wetland systems throughout the Experimental Forest will continue to exhibit lingering health problems associated with past management practices; that is, management-related landslides, road failures, and stream aggradation will persist for some time as a result of the lag effect in hillslope and channel response to disturbance events.

Stream buffers on DNR-managed lands are expected to reduce cumulative impacts of forest management by: (1) minimizing sedimentation associated with landslides and channel-bank erosion to streams, wetlands, and estuaries; (2) enhancing sources of coarse woody debris and shade for streams and wetlands; and, (3) restoring or retaining mature, compositionally and structurally diverse streamside and wetland forests capable of providing bank stability, habitat components, some degree of wind and microclimate protection, and buffering of management-related disturbances on adjacent uplands. These positive effects complement riparian conservation strategies on adjacent national forest and park lands. The No Action alternative should reduce the basinwide cumulative effects by minimizing riparian and aquatic disturbances from DNR-managed lands. Cumulatively, DNR and federal agencies control slightly more than half of the land base in the OESF. Whether improved conditions on these lands can compensate for or influence substantially disturbances associated with more intensive resource extraction and management on private timberlands is uncertain. However, improving riparian conditions on more than half of the land base is expected to contribute positively toward the enhancement and restoration of river and wetland systems as a whole in the Experimental Forest. These lands undoubtedly will not be subjected in the future to the level and intensity of riparian and aquatic disturbances observed from intensive timber harvest in the 1970s and 1980s, so that riparian conditions can only improve with time.

ALTERNATIVE 2

The Unzoned Forest alternatives likely has a greater potential for reducing management-related disturbances on DNR-managed lands in the OESF than the No Action alternative. This alternative likely would contribute more toward minimizing cumulative effects in the long term because there is greater assurance that the integrity of riparian forests will be maintained via the combined interior-core and exterior buffers. These buffers are expected to reduce the frequency and intensity of harvest and road building impacts from upland areas on riparian and aquatic habitat, as well as the catastrophic effects of windstorm disturbances. Enhanced wetland protection under the Unzoned Forest alternative would also lower the rate and intensity of management-related impacts to watershed hydrologic regimes and important riparian habitat. In addition, comprehensive road-maintenance plans would substantially improve control of sediment and water delivery from roads by making routine inspections and timely maintenance a priority management practice.

Given that the Unzoned Forest alternative would more successfully minimize cumulative effects on DNR-managed lands, it is likely that this alternative would contribute more substantially toward reducing landscape-wide cumulative effects in the long term. Greater protection of riparian functions and processes on DNR-managed lands potentially would enhance the positive effects of riparian conservation on Late-Successional Reserves and in national park wilderness, as well as offset, to some degree, the continued impacts resulting from lesser protection on private and tribal timberlands by providing healthy habitat and refugia. Intact riparian corridors between DNR-managed lands and adjacent federal lands would improve short- and long-term sustainability of aquatic and riparian habitat. For example, since the majority of destructive landslides and debris flows originate on steeper ground managed by the national forest and DNR, minimization of such disturbances would reduce the potential for basinwide stream sedimentation and estuary infilling that occurs regardless of management practices on private and tribal lands.

Like the No Action alternative, the Unzoned Forest alternative is expected to contribute toward reduction in basinwide cumulative effects over the long term. The same adverse impacts associated with past management legacies, however, are expected regardless of which alternative is implemented. Limited monitoring has occurred on private, state, and federal lands in the OESF; therefore, the ability to assess quantitatively the effect of past, present, and foreseeable future actions currently does not exist.

ALTERNATIVE 3

The Zoned Forest alternative has the same outcome as the Unzoned Forest alternative. See Alternative 2, Section 4.4.2.3i.

Table 4.4.1: Comparison of regulated Forest Practices RMZ widths (WFPB 1995c) with riparian-buffer widths established by current practices to protect unstable ground in some areas of the OESF (i.e., 55 percent of state-managed lands in the Experimental Forest).

Riparian buffer widths in the latter category are given as statistical means, plus or minus a standard deviation. (hd = horizontal distance; sd = slope distance) The number of samples ranged from 100 to 300 for each stream type.

Stream type	RMZ widths (Forest Practices criteria)	Riparian buffer widths (current practices)
1 stream width >75 ft.	100 ft. horizontal distance (hd)	mean = 141-146 hd 146±140 ft. slope distance (sd)
1 stream width <75 ft.	75 ft. hd	
2 stream width >75 ft.	100 ft. hd	mean = 131-136 ft. hd 136±__• ft. sd
2 stream width <75 ft.	75 ft. hd	
3 stream width >5 ft.	50 ft. hd	mean = 88-95 ft. hd 95±__• ft. sd
3 stream width <5 ft.	25 ft. hd	
4	N/A	mean = 78-96 ft. hd 96±__• ft. sd
5	N/A	mean = 85-105 ft. hd 105±__• ft. sd

• Blanks are place-holders for standard deviations; numbers will be added during editing following 60-day public comment period.

Table 4.4.2: Status of known fish stocks in the Olympic Experimental State Forest (modified from WDF et al. 1993).

The following fish stocks are listed by genetic stock, type of stream run, and health status, as per the Salmon and Steelhead Stock Inventory (WDF et al. 1993). DNR's Olympic Region entered into a verbal agreement with affected Native American tribes, the Washington Department of Fish and Wildlife, and the Northwest Indian Fisheries Commission to work toward protection of listed salmon and steelhead stocks.

CLASSIFICATION: **Genetic stock:** **Native or Non-native**
Type of Run: **Wild, Composite, or Cultured (e.g., hatchery)**
Stock status: **HEALTHY, CRITICAL, DEPRESSED, EXTINCT, UNKNOWN**

Species	River, Stream, or Lake				
	E & W Twin	Deep	Pysht	Clallam	Hoko
Fall Chinook		EXTINCT[1]			Native Composite DEPRESSED
Spring Chinook					
Summer Chinook					
Fall Chum	Native Wild HEALTHY	Native Wild HEALTHY	Native Wild HEALTHY	Native Wild UNKNOWN	Native Wild UNKNOWN
Coho	Mixed Wild DEPRESSED	Mixed Wild DEPRESSED	Mixed Wild DEPRESSED	Mixed Wild UNKNOWN	Mixed Wild HEALTHY
Summer Coho					
Fall Coho					
Sockeye					
Winter Steelhead			Unresolved Unresolved HEALTHY	Unresolved Unresolved UNKNOWN	Native Wild HEALTHY
Summer Steelhead					
Cutthroat	Present[1] UNKNOWN				DEPRESSED

[1] Additional information from the Science Advisory Team, OESF riparian conservation strategy (S. C. Shaw, team lead, DNR Forest Practices Division, Olympia, WA)

Species	River, Stream, or Lake				
	Sekiu	Sail	Waatch	Sooes	Ozette
Fall Chinook	NEAR EXTINCTION			Native Cultured UNKNOWN	
Spring Chinook					
Summer Chinook					
Fall Chum	Native Wild UNKNOWN			Non-Native Cultured UNKNOWN	Native Wild UNKNOWN
Coho	Mixed Wild DEPRESSED	Mixed Wild DEPRESSE D	Mixed Composite UNKNOWN	Mixed Composite UNKNOWN	Mixed Wild UNKNOWN
Summer Coho					
Fall Coho					
Sockeye					Native Wild DEPRESSE D
Winter Steelhead	Native Wild HEALTHY				Native Wild UNKNOWN
Summer Steelhead					
Cutthroat					

[1] Additional information from the Science Advisory Team, OESF riparian conservation strategy (S. C. Shaw, team lead, DNR Forest Practices Division, Olympia, WA)

Table 4.4.2 cont'd: Status of known fish stocks in the Olympic Experimental State Forest

Species	River, Stream, or Lake				
	Quileute	Dickey	Sol Duc	Lake Pleasant	Bogachiel
Fall Chinook	Native Wild HEALTHY	Native Wild HEALTHY	Native Composite HEALTHY		Native Wild HEALTHY
Spring Chinook			Non-Native Composite HEALTHY		
Summer Chinook	Native Wild HEALTHY		Native Wild HEALTHY		Native Wild HEALTHY
Fall Chum	Native Wild UNKNOWN	Present[1] UNKNOWN	Present[1] UNKNOWN		Present[1] UNKNOWN
Coho					Present[1]
Summer Coho			Native Composite HEALTHY		
Fall Coho		Native Wild HEALTHY	Native Composite HEALTHY		Native Wild HEALTHY
Sockeye				Native Wild UNKNOWN	
Winter Steelhead	Native Wild HEALTHY	Native Wild HEALTHY	Native Wild HEALTHY		Present[1] UNKNOWN
Summer Steelhead			Unresolved Wild UNKNOWN		Unresolved Wild UNKNOWN
Cutthroat			Present[1] UNKNOWN		Present[1] UNKNOWN

[1] Additional information from the Science Advisory Team, OESF riparian conservation strategy (S. C. Shaw, team lead, DNR Forest Practices Division, Olympia, WA)

Species	River, Stream, or Lake				
	Calawah	Hoh	Kalaloch	Queets	Clearwater
Fall Chinook	Native Wild HEALTHY	Native Wild HEALTHY		Native Wild HEALTHY	Native Wild HEALTHY
Spring Chinook		Native Wild HEALTHY		Native Wild DEPRESSE D	Native Wild DEPRESSE D
Summer Chinook	Native Wild UNKNOWN	Native Wild HEALTHY		Native Wild DEPRESSE D	Native Wild DEPRESSE D
Fall Chum		Unknown Unknown UNKNOWN		Unknown Unknown UNKNOWN	
Coho		Native Wild HEALTHY[2]	Native Wild UNKNOWN	Native Composite HEALTHY	Native Composite HEALTHY
Summer Coho					
Fall Coho	Native Wild HEALTHY				
Sockeye					
Winter Steelhead	Native Wild HEALTHY	Native Wild HEALTHY[2]	Native Wild UNKNOWN	Native Wild HEALTHY	Native Wild HEALTHY
Summer Steelhead	Unresolved Wild UNKNOWN	Native Wild UNKNOWN		Native Wild HEALTHY	Native Wild UNKNOWN
Cutthroat					

[1] Additional information from the Science Advisory Team, OESF riparian conservation strategy (S. C. Shaw, team lead, DNR Forest Practices Division, Olympia, WA)
[2] Status of stocks in Goodman and Mosquito Creeks (part of Usual and Accustomed Area for the Hoh Tribe) unknown

Table 4.4.3: State-listed plants likely to occur in riparian areas within the Olympic Experimental State Forest

The following species are listed as endangered, threatened, sensitive, and in need of monitoring by the Natural Heritage Program (DNR 1994a), correlated with habitat and range information from Buckingham and Tisch (1979). For the purposes of this analysis, the term "riparian" is applied to wetlands and streams.

CLASSIFICATION: **T: Threatened**
S: Sensitive
M: Monitor
(M1, M2 = status unknown, more data needed; M3 = more abundant and/or less threatened than previously assumed)

Species Name	Common Name	Rarity Status	Indicator Status
Anemone oregana var. felix	Oregon anemone	M3	obligate[1]
Agoseris elata	Tall agoseris	S	
Botrychium lanceolatum	Lance-leaved grapefern	S	facultative wetland[2]
Caltha asarifolia	Caltha palustris	M3	obligate[2]
Carex anthoxanthea	Yellow-flowered sedge	S	obligate[1]
Carex buxbaumii	Buxbaum's sedge	S	obligate[2]
Carex interrupta	Green-fruited sedge	M3	obligate[2]
Carex pauciflora	Few-flowered sedge	S	obligate[1]
Carex pluriflora	Several-flowered sedge	S	obligate[2]
Carex saxatilis var. major	Russet sedge	S	facultative wetland[2]
Carex stylosa	Long-styled sedge	S	facultative wetland[2]
Cochlearia officinalis	Greenland scurveygrass	S	facultative wetland[2]
Coptis asplenifolia	Spleenwort goldthread	S	facultative[2]
Crassula aquatica	Aquatic pygmy-weed	M3	obligate[2]
Epipactis gigantea	Giant helleborine	S	facultative wetland[2]
Erythronium revolutum	Pink fawnlilly	S	facultative[2]

[1] estimates based on field observations and examinations of voucher specimens and data supplied by other collectors (N. M. Buckingham, retired, Port Angeles, WA, pers. commun. to J. Gorsline, OESF Science Advisory Team, 1995)
[2] Reed 1988, 1993

Table 4.4.3 cont'd: State-listed plants likely to occur in riparian areas within the Olympic Experimental State Forest

Species Name	Common Name	Rarity Status	Indicator Status
Fauria crista-galli var. crista-galli	Deer cabbage	M3	obligate[2]
Gentiana douglasiana	Swamp gentian	S	obligate[2]
Hydrocotyle ranunculoides	Water-pennywort	M1	obligate[2]
Lobelia dortmanna	Water lobellia	T	obligate[2]
Lycopodiella inundata	Bog clubmoss	S	obligate[2]
Microseris borealis	Boreal microseris	S	obligate[1]
Parnassia palustrus sp. neogaea	Northern grass-of-parnassus	S	obligate[1]
Plantago macrocarpa	Alaskan plantain	S	obligate[2]
Poa laxiflora	Loose-flowered bluegrass	T	facultative[1]
Poa marcida	Withered bluegrass	M3	facultative wetland[2]
Polemonium carneum	Great polemonium	T	facultative[1]
Scirpus atrocinctus	Black-girdled wool-grass	M3	obligate[2]
Sidalcea hendersonii	Henderson's checkermallow	M3	facultative wetland[2]
Sparganium fluctuans	Waving bur-weed	M1	obligate[2]
Utricularia intermedia	Flat-leaved bladderwort	S	obligate[2]
Utricularia minor	Lesser bladderwort	M1	obligate[2]

1 estimates based on field observations and examinations of voucher specimens and data supplied by other collectors (N. M. Buckingham, retired, Port Angeles, WA, pers. commun. to J. Gorsline, OESF Science Advisory Team, 1995)
[2] Reed 1988, 1993

Table 4.4.4: Water-quality-limited streams in the Olympic Experimental State Forest

These streams are listed as water-quality-limited under Section 303(d) of the Clean Water Act, by the Washington Department of Ecology (1994) acting under the direction of the U.S. Environmental Protection Agency.

Stream Segment Number	Stream Name	Parameter Exceeding Standards
WA-19-1020	Pysht River, S.F.	Temperature
WA-19-1040	Green Creek	Temperature
WA-19-2020	Little Hoko River	Temperature
WA-19-4500	Deep Creek	Temperature, Fine Sediment
WA-19-5000	Clallam River	Temperature
WA-20-1033	Maxfield Creek	Temperature
WA-20-2090	Fisher Creek	Temperature
WA-20-2100	Split Creek	Temperature
WA-20-2110	Line Creek	Temperature
WA-20-2150	Nolan Creek	Temperature
WA-20-2200	Anderson Creek	Temperature
WA-20-2270	Winfield Creek	Temperature
WA-20-2280	Alder Creek	Temperature
WA-20-2300	Willoughby Creek	Temperature
WA-20-2330	Rock Creek	Temperature
WA-20-2350	Tower Creek	Temperature
WA-20-2400	Maple Creek	Temperature
WA-20-2500	Owl Creek	Temperature
WA-20-2600	Canyon Creek	Temperature

Table 4.4.4 cont'd: Water-quality-limited streams in the Olympic Experimental State Forest

Stream Segment Number	Stream Name	Parameters Exceeding Standards
WA-20-5010	Coal Creek	Temperature
WA-20-5100	Dickey River, W.F.	Temperature
WA-20-5200	Dickey River, E.F.	Temperature
WA-20-5300	Dickey River, M.F.	Temperature
WA-20-6210	Dickey River, N.F.	Temperature
WA-20-1100	Coal Creek	Temperature
WA-20-3000	Kalaloch Creek	Temperature

Table 4.4.5: Average riparian-buffer widths, rounded up to the nearest 10 feet, derived from a statistical analysis of buffer protection previously applied to about 55 percent of state-managed lands on the OESF (see text for discussion)

Widths are expressed for each stream type as average horizontal distances measured outward from the active 100-year floodplain margin (generally coincident with the active channel margin in the OESF) on either side of the stream.

Stream type	Width of riparian interior-core buffer (horizontal distances)
1	150 ft.
2	150 ft.
3	100 ft.
4	100 ft.
5	100 ft.

Table 4.4.6: Average widths of the OESF exterior riparian buffer

Widths are expressed for each stream type as average horizontal distances measured outward from the interior-core buffer on either side of the stream. Widths are proposed as a working hypothesis and are based on local knowledge of windthrow behavior. Buffer widths and design will be evaluated through experiments in buffer design on the OESF.

Stream type	Width of riparian exterior buffer (horizontal distances)
1	150 ft.
2	150 ft.
3	150 ft.
4	50 ft.
5	50 ft.

Table 4.4.7: Comparison of average interior-core buffer widths, by stream type, with site potential tree heights based on 50-, 100-, and 120-year growing periods (see Section 4.4.2.3c for discussion)

Stream Type	Average interior-core buffer width	Site potential tree height		
		50-yr. period	100-yr. period	120-yr. period
1	150 ft.	108 ft.	155 ft.	168 ft.
2	150 ft.	108 ft.	155 ft.	168 ft.
3	100 ft.	105 ft.	153 ft.	165 ft.
4	100 ft.	105 ft.	153 ft.	165 ft.
5	100 ft. (est.)	105 ft.	153 ft.	165 ft.

Figure 4.4.1: Schematic example of interior-core and exterior riparian buffers placed on a stream in the OESF

The interior-core buffer includes the active channel(s), channel banks, and unstable ground associated with the banks, flood plains, and adjacent hillslopes. The average width is based on a statistical analysis of current management practices to protect unstable areas (see text). The exterior buffer includes part or all of the channel flood plain and will be designed experimentally with the purpose of protecting the interior-core buffer from wind and upland-management disturbances.

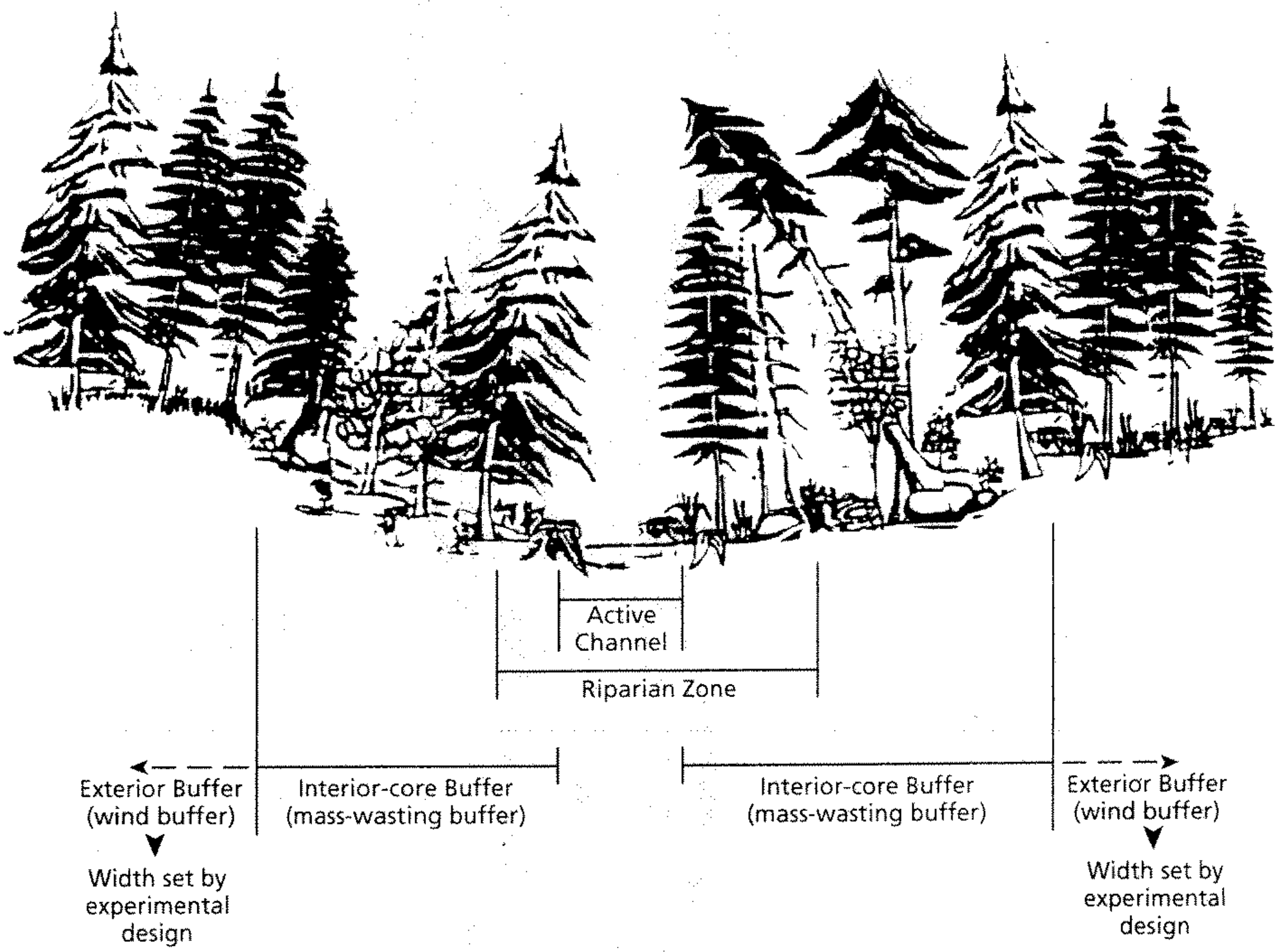


Figure not drawn to scale.

Figure 4.4.2: Schematic example of a riparian buffer on a Type 5 channel

The buffer (heavy line) encompasses the channel initiation point and headwall upslope of it (if present), the active channel, and the channel banks outward on either side to the topographic break in slope.

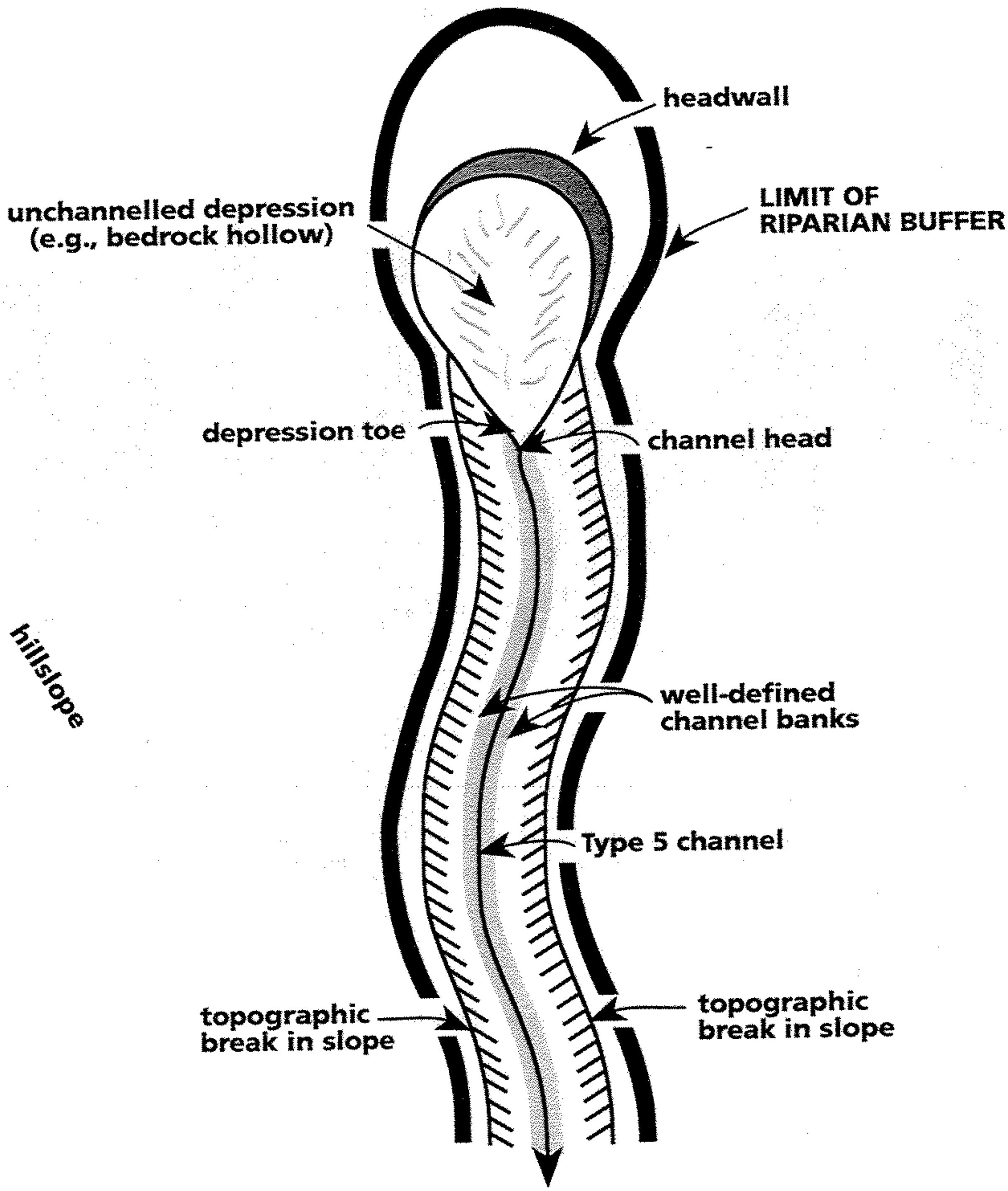
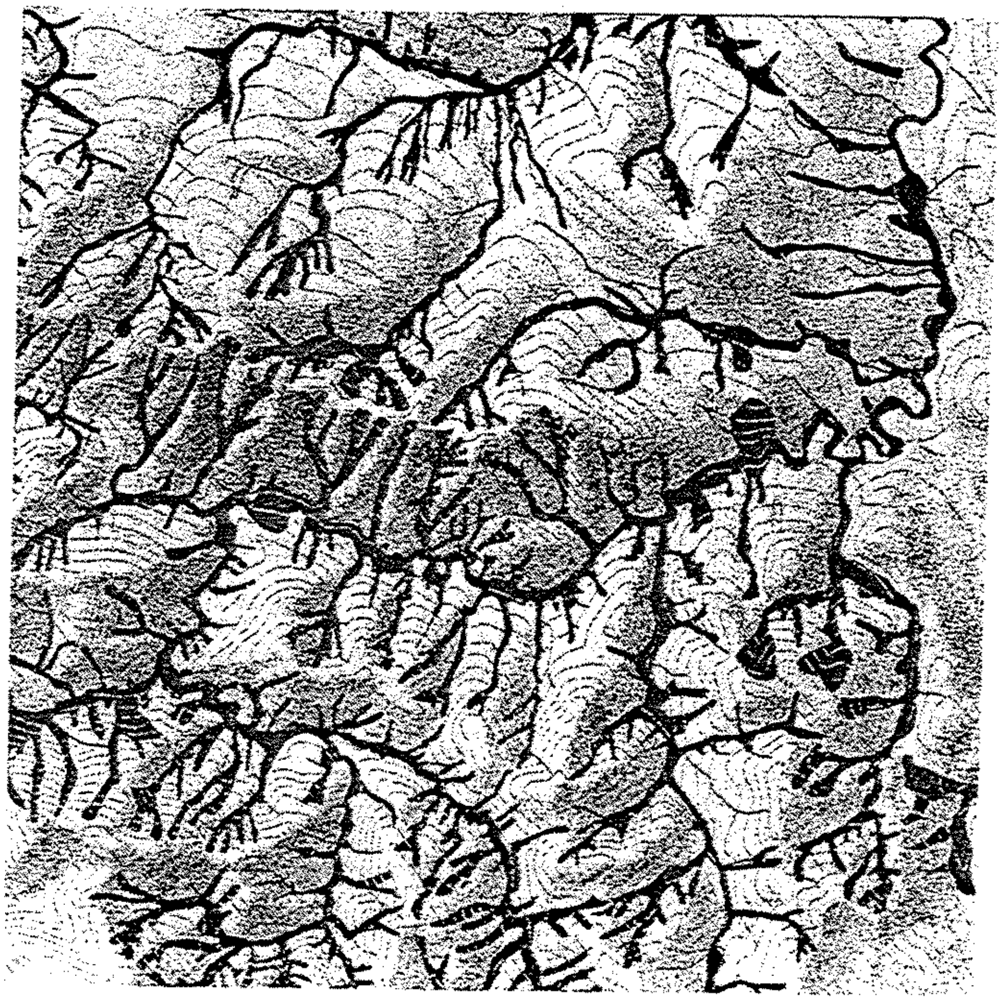


Figure 4.4.3: Example of riparian buffers currently being applied on a portion of the Clallam River landscape to protect unstable channel banks and adjacent hillslopes

This mass-wasting inventory was produced using field data and evaluations of historical information.



Clallam River Mass Wasting Potential

example from the Clallam River Landscape

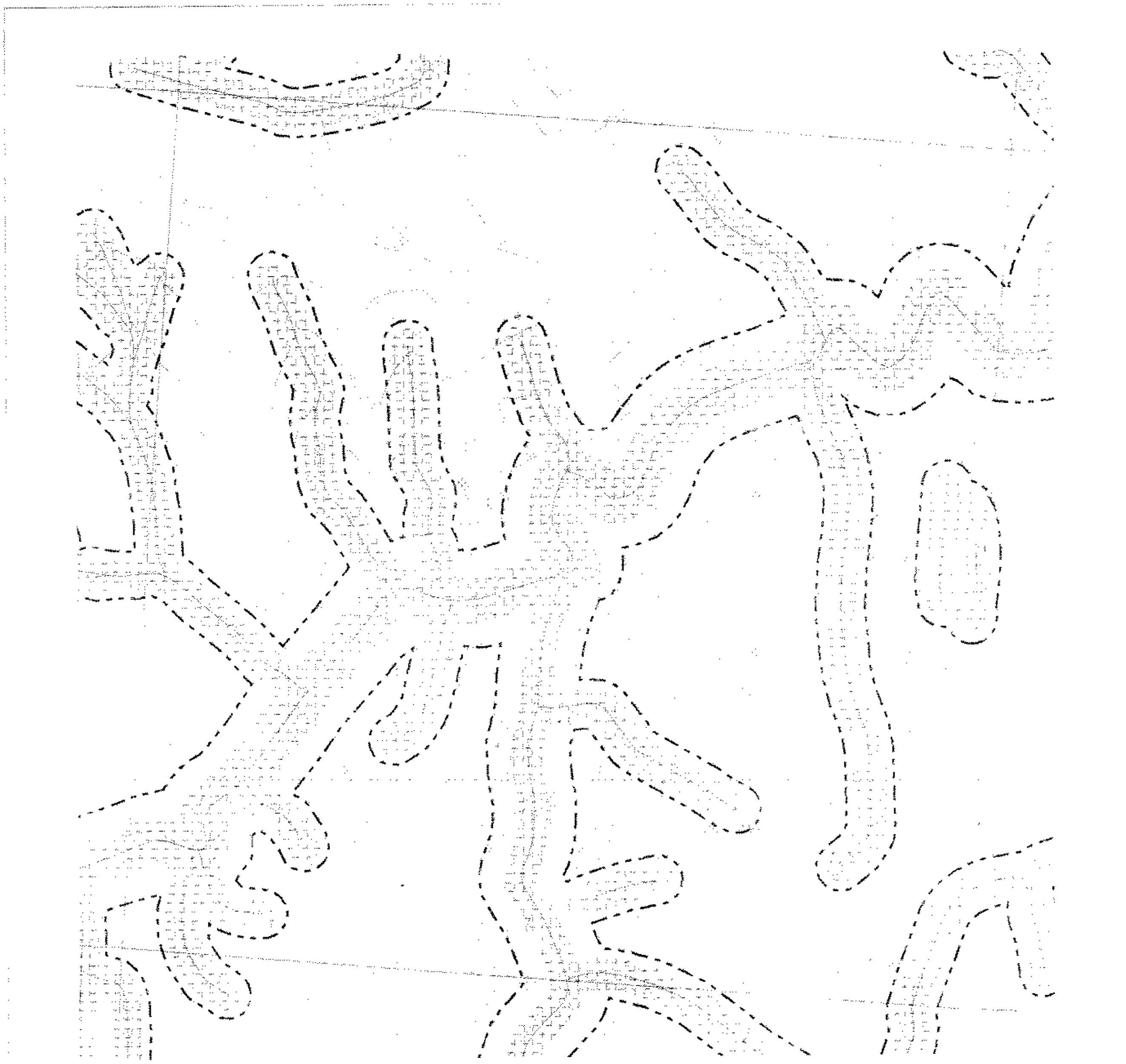
■ Mass Wasting Potential area as defined for the Clallam River Landscape Plan

Contour Lines, 100 foot intervals

OESF Planning Document
March 3, 1995

Figure 4.4.4: Application of interior-core and exterior buffers to a segment of the Clallam River and its tributaries

This example assumes that average widths are set distances; buffers have not been adjusted to meet site-specific requirements for protecting unstable ground. Interior-core buffers average the same dimensions for the No Action and Action alternatives. Exterior buffers are added in OESF Alternatives 2 and 3.

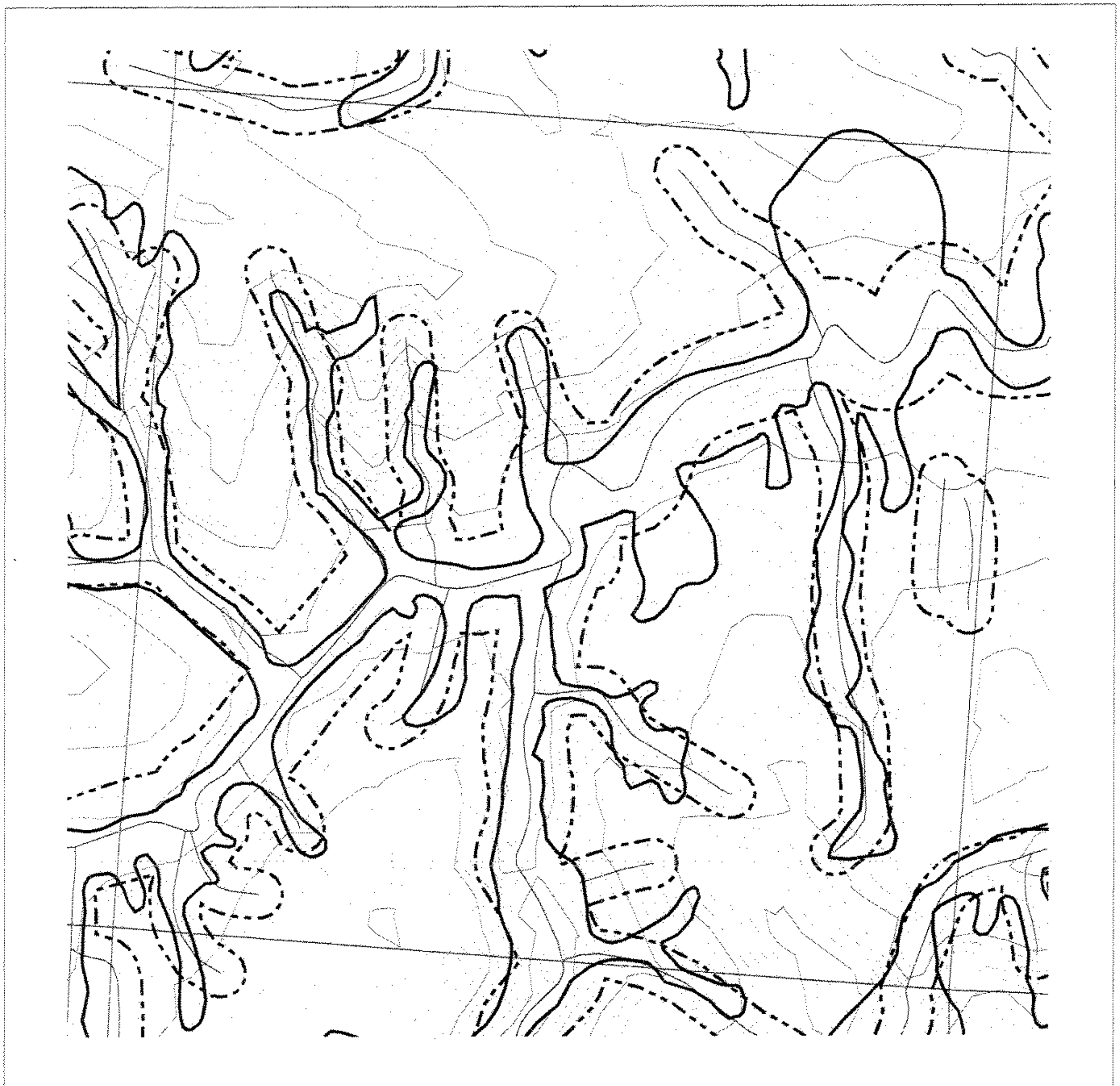


External riparian buffer

Interior-core riparian buffer

T31N R12W - Sec. 8
Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

Figure 4.4.5: Comparison of interior-core and exterior buffers combined (dashed line; same as Figure 4.4.4) with buffers designed in the field to protect mass- wasting sites (solid line)



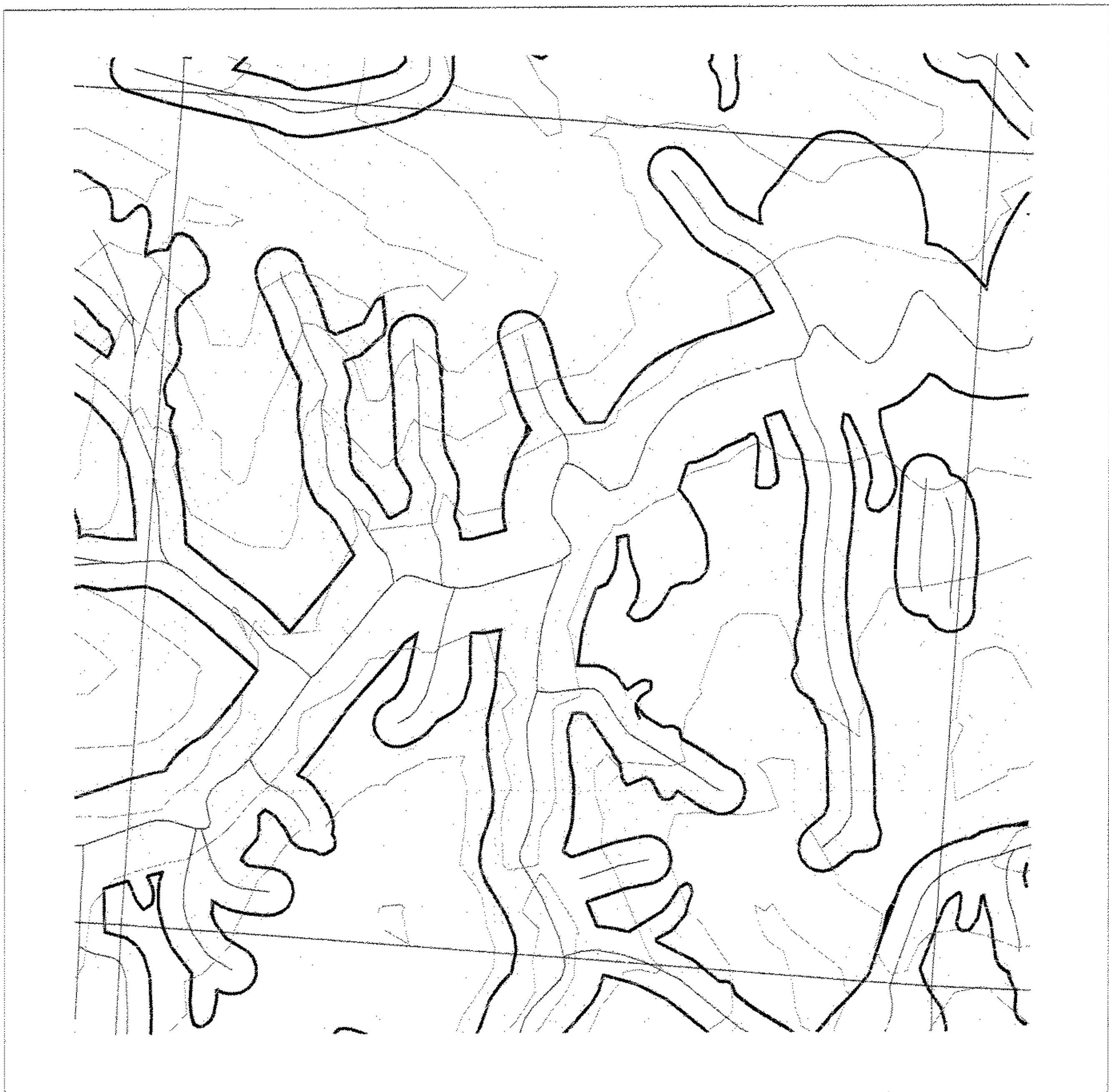
External riparian buffer

Mass-wasting buffer

T31N R12W - Sec. 8
Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

Figure 4.4.6: One possible example of a buffer configuration that results from adjusting interior-core and exterior buffers (see Figure 4.4.4) to protect known mass-wasting sites (see Figure 4.4.5)

This buffer would be fine-tuned on the ground to ensure that it meets known site requirements for protecting riparian physical and biological functions.



T31N R12W - Sec. 8
Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

Matrix 4.4.2b: Summary of potential environmental consequences for OESF riparian strategy

	Alternative 1 - No Action	Alternative 2 - Unzoned Forest	Alternative 3 - Zoned Forest
Mass wasting and channel-bank instability	Moderate to moderately high level of protection for mass-wasting sites, via interior-core buffers. Some uncertainty that these buffers will be adequate spatially or temporally to protect key physical channel and hillslope parameters. Sufficient protection potentially will exist everywhere in the OESF when FRP implemented fully.	Same or greater protection than Alternative 1. Greater protection from expanded buffers (interior-core and exterior combined). Greater protection to integrity of interior-core buffers (via exterior buffers). Greater potential for research and monitoring to improve understanding of riparian systems and strengthen management strategies.	Same as Alternative 2.
Windthrow	Variable protection from wind disturbances of riparian stands, ranging from adequate to none. No systematic or reliable, reproducible approach for treating wind-prone areas.	Greater protection of windthrow-prone riparian areas through exterior buffers. Experiments, designed to resolve problematic interactions between forest management and windthrow, will be part of research and monitoring program. Some potential risk for loss of buffer effectiveness, resulting from experimentation. Greater potential for increased knowledge and long-term conservation benefits through experimental program.	Same as Alternative 2.

	Alternative 1 - No Action	Alternative 2 - Unzoned Forest	Alternative 3 - Zoned Forest
Coarse woody debris	Potentially sufficient short- and long-term sources of coarse woody debris for streams when FRP fully implemented. Currently, good wood sources are nonexistent to adequate, depending on site location. Where interior-core buffers have been established for mass-wasting protection, long-term recruitment potential is adequate.	Similar to Alternative 1 for recruitment from interior-core buffer. Increased certainty of adequate supply due to expanded riparian buffers (interior-core and exterior buffers combined). More certain supply of large wood to flood plain and riparian forest floor over time than Alternative 1, due to expanded buffers.	Same as Alternative 2.
Sediment and roads	Moderate level of protection to streams from sedimentation (mass wasting and road erosion) when FRP fully implemented. Road maintenance and repair are adequate on some roads, but a large percentage still cause sedimentation problems.	Moderate to high levels of protection to streams from sedimentation (mass wasting and road erosion). Greater potential for regulating frequency and volume of sediment delivery to streams through aggressive maintenance program and controls on road-network densities.	Same as Alternative 2.
Water temperature	Potentially adequate stream shading under full implementation of FRP. Currently, shade availability is highly variable due to inconsistent riparian management zone practices (buffers nonexistent to adequate, depending on site).	Increased certainty of adequate shading due to interior-core buffers, exterior buffers in wind-prone areas, and an emphasis on enhancing conifer component and canopy structural diversity in riparian management zones.	Same as Alternative 2.
Stream flow	Low potential for regulating road-drainage volumes or water yields associated with timber harvest.	Greatest potential for regulating quantity and timing of surface runoff to streams, minimizing impacts associated with drainage discharges to streams, and regulating forest hydrologic maturity. Potential for new knowledge through monitoring and research.	Greater regulation of water volumes and discharge rates than Alternative 1, but less than Alternative 2.

	Alternative 1 - No Action	Alternative 2 - Unzoned Forest	Alternative 3 - Zoned Forest
Nutrient productivity	Expected to provide a large percentage of detrital nutrients to stream channels via the interior-core buffers, provided that FRP is fully implemented. Expectations are qualified by present lack of understanding regarding nutrient-cycling processes.	Increased chance of providing adequate detrital nutrients via combined interior-core and exterior buffers, and emphasis on enhancing future biodiversity of riparian forests. Increased opportunities for research and monitoring of nutrient-cycling processes.	Same as Alternative 2.
Microclimate	Inadequate in some areas, especially where buffers are nonexistent, insufficiently wide, or fragmented. Expected to provide protection to at least some of the key microclimate parameters on as much as 94% of the streams over time, as FRP policies become fully implemented.	Increased certainty of providing protection to microclimate parameters, due to expanded width of buffers (interior-core and exterior combined), and to improved management strategies resulting from research and monitoring in riparian buffers.	Same as Alternative 2.
Riparian system functions	Moderate level of protection in most cases, provided that FRP is fully implemented. Currently, the physical and biological conditions of most major stream systems are declining; this decline will continue unless FRP is fully implemented.	Greater potential for protection due to more systematic and interdisciplinary approach to designing conservation measures; more consistent buffer strategies; aggressive road-maintenance plans; and better integration of riparian and upland conservation strategies.	Same as Alternative 2.

4.4.3 Analysis of the Northern Spotted Owl Conservation Strategy for the Olympic Experimental State Forest

Affected Environment

The effectiveness with which the No Action, Zoned Forest, and Unzoned Forest alternatives address current and likely future threats to the viability of spotted owls on the Olympic Peninsula are a basis for evaluating these alternatives. Thus, it is necessary to understand current and likely future threats, how those threats are manifest (i.e., the information used to establish qualitative or quantitative measures of the threats), and how the three alternatives will address those threats in order to develop this evaluation. This section provides a brief summary and discussion of the current understanding of threats to spotted owls on the Olympic Peninsula, and information that can be used to evaluate those threats.

Threats to Owls on the Olympic Peninsula

There have been two major discussions and analyses of threats to the viability of spotted owls on the Olympic Peninsula, one presented by the recovery team in the federal Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a), the other by the Reanalysis Team (Holthausen et al. 1994). These two teams discussed essentially the same risk factors, but used different approaches and information bases for their analyses. Many of the recovery team's interpretations were based on radio-telemetry and banding studies, conducted mostly on the Olympic National Forest between 1987 and 1991, and projections based on those data and then-current policies. The Reanalysis Team's interpretations were based on those data, plus 3 more years of banding studies that were expanded into Olympic National Park, extensive sampling of Olympic National Park that enabled a much better population estimate for that area, and an intensive radio-telemetry study of juvenile dispersal and survival. They used sophisticated computer modeling, a program that simulated spotted owl life histories in response to actual and hypothetical landscape conditions on the Olympic Peninsula, to project responses of the owl population to different sets of assumptions and habitat conditions. Their projections for changes to habitat conditions in the future were developed under a substantially different federal forest management policy (USDA and USDI 1994b).

The recovery team identified low population levels, declining populations, poor population distribution, habitat loss, population isolation, and natural disturbances as major threats to the viability of owls on the Olympic Peninsula. They estimated a population of 200, plus or minus 25 pairs, that was declining at an annual rate of 12 percent. They characterized the current distribution of owls as a "doughnut" with owls largely restricted to the mid-elevation forests on mainly federal lands because timber harvests on lower elevation, mostly nonfederal lands had largely eliminated their capability as habitat. And, they expected that habitat loss due to timber harvest would continue at high rates under then-current management regimes. They presumed that the isolation of the Olympic Peninsula sub-population from other reproductive owls placed it at risk of extinction or inbreeding if catastrophic or stochastic events caused it to decline severely. Catastrophic fire and/or wind were predicted under a worst-case scenario to be able to reduce the habitat capability by up to 30 percent over 100 years (USDI 1992a).

Holthausen et al. (1994) presented different interpretations of risks to the viability of spotted owls on the Olympic Peninsula than did the recovery team (USDI 1992a). They estimated a population size of 282 or 321 pairs, depending on which set of assumptions they used. They cautiously estimated that the population was stable. Their evaluations of risk to the Olympic Peninsula sub-population posed by the spatial and ecological distribution of habitat generally concurred with those of the recovery team. They concluded that it was unlikely that owls would continue to occupy coastal lowlands in the OESF area without habitat on nonfederal land. The current plans for management of the Olympic National Forest have established large reserves in which owl habitat will be maintained and/or restored (USDA and USDI 1994a). In light of these management plans for federal lands, Holthausen et al. (1994) concluded that "...it is likely, but not assured, that a stable population would be maintained on portions of the Olympic National Forest and the core area of the national park in the absence of any nonfederal contribution of habitat."

Holthausen et al. (1994) also evaluated the risks to viability of the sub-population posed by its isolation. They simulated the effects of establishing a significant (370,500 acres of high-quality habitat) chain of small reserves connecting owls in the southern Cascades and Olympic Peninsula. They concluded that these connecting reserves had little effect on the stability of the sub-population; in other words, isolation appeared not to be as serious a threat as the recovery team (USDI 1992a) thought. Based on their analyses, Holthausen et al. (1994) suggested that the total area managed for habitat on federal lands on the Olympic Peninsula is large enough that an otherwise stable population of owls would be robust to large-scale disturbances.

An additional threat that both groups identified but could not quantify is the risk that barred owls (*Strix varia*) could outcompete spotted owls for limited resources, thus excluding them from otherwise suitable habitat.

Size of the Olympic Peninsula Owl Population

The most up-to-date and rigorous estimate of the number of spotted owl pairs on the Olympic Peninsula was provided by Holthausen et al. (1994). They used three sources of data for their estimate: extrapolations from the WDFW interagency spotted owl database for DNR-managed, private, and tribal lands (a nearly complete inventory of territorial owls); extrapolations from nearly complete inventories of territorial owls conducted by the USFS Pacific Northwest Research Station since 1987 on the Olympic National Forest (Forsman 1992a); and estimates of density for Olympic National Park based on extrapolating from the density of territories located in randomly selected sample areas (Seaman et al. 1992). The Olympic National Park density estimates are the results of preliminary analyses, and await incorporation of data from the 1995 field season and further statistical analysis to refine the point estimate and develop confidence intervals for the estimate.[1] Holthausen et al. (1994) used two sets of assumptions to develop two

[1] Seaman (1995) reported results of completed analyses of Olympic National Park owl surveys. He estimated 229 owl pairs with a 90 percent confidence interval of 158-300 pairs. Combining his estimate with the two sets of assumptions of Holthausen et al. (1994) results in a revised estimate of 267-448 spotted owl pairs for the Olympic Peninsula.

estimates for the numbers of owl pairs on the Olympic Peninsula: a lower estimate derived by adding the known pairs (and, at least for DNR-managed lands, sites at which pairs had been observed in the past) on Olympic National Forest and DNR-managed lands to the estimated numbers in Olympic National Park; and a higher estimate derived by adding the known pairs and other sites where owls had been located but pairs not documented on Olympic National Forest and DNR-managed lands to the estimated numbers in Olympic National Park. Thus, they estimated either 282 or 321 pairs of spotted owls on the Olympic Peninsula.[2] This is substantially more pairs than previously estimated. For example, Thomas et al. (1990) estimated a population of 177 pairs, and the recovery team (USDI 1992a p. 41, 144) variously estimated 175 to 225 pairs and 175 to 200 pairs.

Trends in the Olympic Peninsula Owl Population

Burnham et al. (1994) used data from banding studies between 1987 and 1993 to estimate the rate of change in the population of resident female owls on the Olympic Peninsula (the population of resident females ultimately equates to the entire population because they produce the juveniles that maintain the population). They estimated the annual rate of population change (λ) for the Olympic Peninsula using: estimates of the annual probabilities of subadult and adult female survival; fecundity rates, i.e., the rates at which subadult and adult female owls produce female hatchlings; and, the "apparent" probability that juvenile female owls would survive 1 year (ϕ). They estimated that, during the period 1987 to 1993, the population of resident female owls on the Olympic Peninsula declined at a rate of 5.3 percent per year (standard error 2.6 percent).

Adult survivorship

Survival rates are estimated based on annual re-observation of banded owls. Simulation modeling suggests that the survival rate of adult females is the aspect of spotted owl life history that most strongly influences rates of population change (Noon and Biles 1990). Estimates of adult female survival probabilities average 0.844 plus or minus 0.005 across the owl's range, and 0.862 plus or minus 0.017 for the Olympic Peninsula sub-population (Burnham et al. 1994). While their meta-analysis of survival rates across the range of the owl indicated that survival rates were declining, they found that these rates did not change during the study on the Olympic Peninsula. Survival rates for males may be higher; Forsman (1992b) estimated annual survival probabilities for Olympic Peninsula males at 0.893 plus or minus 0.026 for the period 1987-1992.

Fecundity

Average annual fecundity rates from 11 geographically distinct study areas varied from 0.231 to 0.565; the median value was 0.323 (Burnham et al. 1994). Annual fecundity in the Olympic Peninsula study area was 0.380, or 0.76 young per pair per year. There is considerable annual variation in reproductive effort within and among sub-populations of spotted owls, and among individual owl pairs within years, e.g., Forsman et al. (1984) observed nesting in 16-89 percent ($\bar{x}$ = 62 percent) of pairs during a 5-year study in

[2] Ibid.

Oregon. Annual variation in fecundity in seven geographically distinct areas with at least 5 years of study ranged from 0.3 percent to 13.4 percent (coefficient of variation, median = 5.6 percent, see Thomas et al. 1993 Table 4-3). Annual variation in fecundity of the Olympic Peninsula sub-population was third highest, coefficient of variation = 10.2 percent. Reproductive rates of owls on the Olympic Peninsula thus seem to be consistent with those observed elsewhere in the species' range, but annual variability in reproduction is relatively high.

Juvenile dispersal

Spotted owls leave their natal territories after their first summer. This dispersal appears to be innate (Howard 1960), and may function to maintain the species' distribution in available habitat and maintain genetic diversity among sub-populations (Howard 1960; Greenwood and Harvey 1982). Early studies of dispersing juvenile owls used backpack-mounted radio-transmitters (Forsman et al. 1984; Guttièrez et al. 1985; Miller 1989) or relied on re-observations of owls banded as fledglings (Forsman 1992a) to track their movements and survival. These studies provided information on the directions and distances of movement, habitat associations, and survival rates. However, there is evidence that the relatively large, backpack-mounted radio-tags influenced survival (Paton et al. 1991) and reproduction (Paton et al. 1991; Foster et al. 1992) of adult owls (with the inference that they may have influenced behavior and survival of juveniles as well), and that emigration of banded owls from study areas causes underestimates of survival (Forsman 1992b).

Dispersing juvenile owls in three study areas from the 1991 (Miller et al. 1992) and 1992 cohorts (Forsman 1992b) were radio-tagged with much smaller transmitters mounted on their tail feathers (a new system with presumably less effect on their behavior). These studies are beginning to provide important, additional information on habitat relationships, dispersal distances, rates of emigration, and survival probabilities. Preliminary estimates of first-year dispersal distances ($\bar{x}$ = 15.12 plus or minus 0.98 miles) of 111 juveniles from the Olympic Peninsula and the east slope of the Cascade Range (E. D. Forsman, USFS, Corvallis, OR, pers. commun., 1995) are similar to those reported by earlier radio-telemetry studies (Guttièrez et al. 1985; Miller 1989). Dispersal distances for 31 juveniles on the Olympic Peninsula ranged from 5.39 to 36.20 miles, and averaged 15.05 plus or minus 1.58 miles (E. D. Forsman, USFS, Corvallis, OR, pers. commun., 1995). In the four known cases of dispersal to and/or from DNR-managed land in the OESF, owls banded as fledglings were recaptured 9, 14, 18, and 30 miles from their natal sites as adult or subadult members of pairs.

Juvenile survivorship and estimating the rate of population change

There are several sources of bias in the Burnham et al. (1994) estimate of λ, the most serious of which is the negative bias introduced by using estimates of ϕ, the "apparent" rate of juvenile survival (Burnham et al. 1994; Holthausen et al. 1994; Bart 1995). Burnham et al. (1994) attempted to account for this bias while examining their hypothesis that the population was declining. They calculated that the juvenile survival rate needed to be 0.413 for a stable Olympic Peninsula sub-population (Burnham et al. 1994 Table 9), which when compared to their estimate of ϕ (0.245, Burnham et al. 1994 Table 5) suggests that their conclusion of a declining population was correct. Then, to correct ϕ, they estimated emigration rates E, based on radio-telemetry studies of juvenile owls in the Roseburg, Oregon area and on the Olympic Peninsula and used those rates to estimate the "true" juvenile survival probability (S). They estimated S for all study areas combined (11 areas across the range of the northern spotted owl) as 0.377 (standard error 0.060) and produced a less biased estimate of λ across all 11 study areas of 0.916 to 0.993.

However, Burnham et al. (1994) did not continue their analyses to the point of estimating adjusted S and the resultant λ for the Olympic Peninsula. But, using their data and available methods, it is possible to do so (methods and calculations are summarized in Appendix D). Using the data and methods of Burnham et al. (1994), $S = 0.358$, with a 95 percent confidence interval of 0.147 to 0.645 (Appendix D). Comparing that range to the value needed to result in a stable Olympic Peninsula sub-population ($S = 0.413$, Burnham et al. 1994 Table 9) suggests that their analysis failed to support their hypothesis that the Olympic Peninsula sub-population is declining. In fact, solving for λ using that estimate and range of S results in $\lambda = 0.984$, with lower and upper estimates of 0.915 and 1.068 for the Olympic Peninsula sub-population.

Furthermore, Burnham et al. (1994) argued that they did not have area-specific estimates of emigration rates, and thus could not derive area-specific, adjusted juvenile survival rates. But the E they used was derived by averaging over two study areas in which the estimates differ markedly (13/57 = 0.228 Roseburg, OR; 11/19 = 0.579 Olympic Peninsula, Burnham et al. 1994). These areas are profoundly different in the degree to which owls are able to disperse from them to areas inaccessible to normal re-observation techniques. Roseburg is entirely commercial forest lands, accessible by road throughout, and mostly surrounded by other study areas. In contrast, almost half of the owl habitat on the Olympic Peninsula study area is in Olympic National Park which is nearly roadless and extremely difficult to survey for owls. No other study areas border the Olympic Peninsula. Thus, while Holthausen et al. (1994) correctly note that the area-specific E and S should be viewed with caution because few data were used to derive them (they used a study of 35 owls over 2 years, one of which had an exceptionally mild winter that may have favored juvenile survival), there are some data and sound logic with which to develop an estimate of E specific to the Olympic Peninsula. Holthausen et al. (1994) used data additional to that reported by Burnham et al. (1994) to estimate E for the Olympics at 0.600 (standard error 0.083). This results in $S = 0.612$ (standard error 0.204). While this estimate is not conclusive, it suggests that survival rates may be substantially higher than the metapopulation estimate reported by Burnham et al. (1994). In fact, Holthausen et al. (1994) estimated $\lambda = 1.058$ (standard error 0.065), using their Olympic Peninsula-specific adjustment of juvenile survival rates. Their estimate was not significantly different from $\lambda = 1$, a stable population. They advised that this estimate be interpreted with caution for the reasons noted in the discussions of juvenile survival.

Geographic and Ecological Distribution of Spotted Owls and their Habitat

Stand-level habitat relationships

Old-forest stands are preferred by spotted owls in western Washington and Oregon for nesting, roosting, and foraging; however, it appears that owls' requirements become increasingly general from nesting to roosting to foraging habitat (reviewed by Horton in press). While few owls have been found nesting outside of old, unmanaged stands, some use younger managed and unmanaged stands for roosting, and many use those stand-types (at least occasionally) for foraging (Thomas et al. 1990; Horton in press). The relationships of owls to forest stand conditions in the western Olympic Peninsula mirrors that observed throughout their range. Preliminary analyses of foraging habitat selection by 20 owls (Forsman 1991) showed that trend.

Landscape-level habitat relationships

Spotted owls are known to occur up to 3,500 feet in elevation in the western Olympic Peninsula, but no nests are known above 2,500 feet (Holthausen et al. 1994). Forests at these elevations are within the Sitka spruce, western hemlock, or silver fir zones (Henderson et al. 1989). Spotted owls feed primarily on medium-sized arboreal and semi-arboreal mammals, which reach their lowest diversity and abundance within the owls' range in forests of these types (Carey et al. 1992). Owls in the western Olympic Peninsula use very large home ranges, probably because of the depauperate prey base (Carey et al. 1992). Forsman (in prep., cited in Holthausen et al. 1994) followed 10 pairs of owls on the western Olympic Peninsula, and they ranged over 4,497-27,309 acres annually
(median = 14,271 acres). Their ranges encompassed 2,787-8,448 acres of old-growth and mature forests (median = 4,579 acres), and pairs ranged more widely when old forests were scarce ($r = -0.73$, $P = 0.10$). The trend towards larger ranges in areas of scarce old forests is consistent with the findings of Carey et al. (1992) in southwestern Oregon. *Lehmkuhl and Raphael (1993) compared the composition and other characteristics of* various-sized circles around owl and random sites on the Olympic Peninsula. They found that the owl sites were located in concentrations of old forests at all scales examined.

Distribution of habitat

Forests in the western Olympic Peninsula above 3,000 feet in elevation are dominated by Pacific silver fir (Henderson et al. 1989) and offer little nesting, roosting, or foraging habitat to resident owls (Holthausen et al. 1994). Those forests occur almost exclusively on federal lands in the OESF area. In 1992, DNR contracted with WDFW to estimate and map land cover in the OESF area with an emphasis on classification accuracy of mid- and late seral forests (WDFW 1994b). Washington Department of Fish and Wildlife conducted a supervised classification of Landsat Thematic Mapper satellite imagery gathered in July 1991 to produce a digital map of the area that sorts land cover among nine categories: old-growth, large-saw, small-saw, pole, sapling, open canopy/mixed conifer, open areas, water, and cloud/cloud shadow (Map 26). The analysis encompassed 1.3 million acres of the northwestern Olympic Peninsula (Table 4.4.8). The majority of older forests, both above and below 3,000 feet in elevation, are in Olympic National Park, significant amounts are also on Olympic National Forest and on DNR-managed lands (Table 4.4.8). Younger forests increase markedly in their dominance of the landscape from east to west (Map 26), such that the coastal plain of the western Olympic Peninsula is markedly depauperate of owl habitat.

It is unlikely that productive spotted owl pairs can persist in coastal lowland forests of the western Olympic Peninsula without at least the maintenance of current habitat there (Holthausen et al. 1994). The persistence of a functional segment of the sub-population in the coastal lowlands is likely to provide significant conservation benefits by maintaining the geographic distribution of pairs on the Olympic Peninsula (potentially 20 percent of the owls' range on the peninsula is in coastal lowlands with abundant DNR-managed land in the OESF), and maintaining owls over the range of ecological conditions they historically occupied. Both benefits are consistent with the philosophy of "spreading the risk" (Den Boer 1981; Thomas et al. 1990) by broadening the geographic and ecological distribution of the sub-population.

Holthausen et al. (1994) concluded that retention of existing habitat in the low-elevation, coastal forests would result in a "...biologically significant contribution..." by maintaining owls in that portion of their distribution. Their simulations predicted that maintaining all current habitat on all nonfederal lands on the peninsula increased the numbers of pairs occupying sites on both federal and nonfederal lands by about 20 percent over simulations based on no nonfederal habitat.

Trends in Habitat

Over half of the area of the northwestern Olympic Peninsula, 712,000 acres, is in younger forest cover or other open conditions, the great majority of these cover-types are the result of harvests of older forests within the past 40 years (Table 4.4.8, Map 26). Over 73,000 acres of old-growth forests were harvested on the Olympic National Forest between 1974 and 1988 (Morrison 1988). Approximately 119,000 acres of DNR-managed forests in the OESF are 30 years old or younger (DNR 1995d); the great majority of these young forests regenerated after harvests of older forests that were potential owl habitat.

However, since about 1990, the rate of harvest of older forests that are potential owl habitat has slowed dramatically on the Olympic Peninsula. This reflects changing management practices by Olympic National Forest, DNR, and private landowners in response to policy changes (e.g., USDA and USDI 1994a) and legal requirements (the ESA, Washington Forest Practices Rules (WAC 222-16-080(1)(h))). It appears that a stable management policy for the Olympic National Forest will maintain and restore large areas of owl habitat (USDA and USDI 1994a) in areas of the Olympic Peninsula that currently support a large proportion of the sub-population. Future directions for policies and rules governing management of nonfederal forest lands are less certain.

Population Isolation, Natural Disturbances, and Barred Owls

Spotted owls on the Olympic Peninsula represent the most northwesterly segment of the species' distribution in the United States, with the most northerly extent of its range in extreme southwestern British Colombia. The Olympic Peninsula is surrounded to the west, north, and east by marine waters, and to the south by large areas of young-aged forest plantations and other developed lands. The nearest areas where owls are reasonably common are 200 miles to the south in the Oregon Coast Range and 75 miles to the east in the Cascade Range in southern Washington. Spotted owls on the Olympic Peninsula are effectively an isolated sub-population. Holthausen et al. (1994) simulated a variety of habitat and population configurations to examine threats to the viability of owls there. The only simulations in which a robust demographic connection to the Cascades sub-population made significant contributions to the viability of owls in the Olympics were those in which very few owls but much habitat remained in the Olympics (an arbitrary reduction in owl numbers by 80 percent relative to habitat capability). They considered this to represent an "extremely unlikely" combination, and concluded that demographic isolation was not a significant threat to the sub-population so long as it is stable or nearly stable. And, they concluded that the stability of the Olympic Peninsula sub-population was primarily dependent on local habitat conditions.

Holthausen et al. (1994) evaluated the effects of a worst-case fire by simulating a complete loss of habitat in portions of the eastern and northern Olympic Peninsula that are at high risk of large-scale fires (33 percent of federal land on the peninsula) (Holthausen et al. 1994 Figure 5). Their analyses suggested that the total area managed for habitat on federal lands is large enough that an otherwise stable population of owls would be robust to a disturbance of this scale. They discussed, but did not analyze, the effects of a large-scale windstorm on the western peninsula in combination with the simulated fire loss. They concluded that such a scenario would cause significantly greater impacts to the peninsula owl population, but that the combination was extremely unlikely. Their choice to forgo analysis of the impacts of a major windstorm on the western peninsula was reasonable because relatively little habitat currently remains on mostly DNR-managed and private lands on the wind-prone coastal plain (Map 26, Table 4.4.8).

Barred owls have expanded their range into western North America and become increasingly sympatric with spotted owls over the past 40 years (Taylor and Forsman 1976; Dunbar et al. 1991). Barred owls may displace and are known to hybridize with spotted owls (Dunbar et al. 1991; Hamer et al. 1994a). They have increased in abundance on the Olympic Peninsula, and will probably continue to do so (Holthausen et al. 1994). They are widely thought to have the potential to represent a threat to spotted owls in many parts of their range, including on the Olympic Peninsula (e.g., Dunbar and Blackburn 1993; Thomas et al. 1993; Holthausen et al. 1994), but there is no way to predict the long-term outcome of interactions among these congeners. Thomas et al. (1993) suggest that there is little that forest management can or should do to influence this outcome.

Matrix 4.4.3a: Management strategies for alternatives related to the OESF Planning Unit

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Spotted Owl			
Nesting, Roosting, and Foraging (NRF) Habitat	Two-year surveys conducted on proposed timber sales to collect/update information on owl sites (no surveys since 1993 in OESF). Within spotted owl site centers, no harvest of owl habitat if existing owl habitat in the (2.7 mile) circle is equal to or less than 40% of the total area. Management of non-habitat will result in maintaining these stands in a non-habitat condition. As owls move or survey information shows an owl activity circle has been abandoned, additional acres would be available for harvest (consistent with the regulatory and policy decertification guidelines currently available). 15,000 acres of suitable habitat are (continued)	Emphasis on developing future habitat distributed across the entire 270,000-acre forest through integrated forest management consists of 2 phases: (1) initiate habitat recovery within each landscape until (a) old-forest habitat (NRF) exceeds 20% of the acres; and, (b) sub-mature and old-forest habitat (RF & NRF), including the 20% above, exceeds 40%; (2) maintain and enhance a mosaic of habitat that shifts over time guided by analyses and plans for individual landscape planning units, working to achieve habitat goals at or greater than the 20% and 40% minimum standards. Near-term harvest of potential habitat is not limited by 40% threshold (this will not delay achieving the target since new acres acquire the structures), but is limited by riparian and murrelet (continued)	Emphasis on strategically located areas designated for owl habitat management. Prescriptions to be achieved within the designated areas over time: (1) Nest Grove - 100% old forest; each 200 acres in size (5,000 acres total) (2) Core Area - 50% sub-mature or better; each 2,000 acres in size (78,000 acres total) (3) Range Area - 40% young-forest marginal or better; each 14,000 acres (40,000 acres total) (4) Special Pair Areas - 40% habitat within 2.7 miles of five selected owl sites (40,000 acres) *Interim provision:* Special pair areas will not be retained after range areas meet or exceed thresholds.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Spotted Owl (continued)			
Nesting, Roosing, and Foraging (NRF) Habitat (continued)	being deferred until 2005. Criteria have not been developed for determining whether the deferral will end or be extended beyond year 2005. Initially this decision was expected to be linked with OESF research results, but that portion of the Commission on Old Growth Alternatives' recommendations was not implemented and is not part of No Action.	strategies and 20% old-forest habitat threshold. Guidelines provided for harvest of suitable owl habitat are linked to (a) riparian and marbled murrelet conservation, (b) old-forest habitat thresholds, (c) an emphasis on the harvest of habitat being a combination of young- and old-forest habitat scheduled somewhat evenly across the recovery period, and (d) opportunities to learn new silvicultural techniques for achieving habitat goals. Known owl nests will not be disturbed during nesting season.	
Dispersal Habitat	No provision for dispersal habitat.	Provided within the landscape requirements for percentage of young-forest marginal and better habitat.	Provided within the nest, core, and range area requirements.
Experimental Areas	No provision for experimental areas.	Entire forest plays role in innovative experimental management, research and monitoring program.	Conduct limited research activities within zones designated to support clusters of spotted owl pairs. Conduct limited second-growth research activities outside zones.

Evaluation of the Alternatives

Summary Evaluation

Three criteria were used in evaluation of the alternatives. Two criteria were the degree to which each alternative addressed major threats to the viability of spotted owls on the Olympic Peninsula: the amount and distribution of owl habitat, and the size and trends in size of the sub-population. The third evaluation criteria was the degree to which each alternative placed owl sites at risk for incidental take.

Two independent analyses of the ability of habitat to support spotted owl pairs generally concurred in their findings. Habitat currently capable of supporting owl pairs is concentrated on the mid-elevation, mostly federal lands at the interior of the Olympic Peninsula. The low-elevation coastal plain, (mostly nonfederal) forest lands that dominate the OESF have little current capability as habitat for owl pairs. Two projections of the No Action alternative 100 years into the future showed that the habitat capability of the interior Olympic Peninsula increases with time, but that little change occurs on the low-elevation lands of the OESF. Two projections of the Zoned Forest alternative 100 years into the future predicted substantial increases in the ability of the low-elevation, coastal plain forests of the OESF to support owl pairs relative to current conditions: one analysis predicted a two-fold increase in the area of DNR-managed lands in the OESF capable of supporting owl pairs; another analysis predicted that the area that included DNR-managed lands in the OESF would be capable of supporting 50 percent more owl pairs. Two projections of the Unzoned Forest alternative 100 years into the future predicted even greater increases in the ability of the low-elevation, coastal plain forests of the OESF to support owl pairs relative to current conditions: one analysis predicted a greater than three-fold increase in the area of DNR-managed lands in the OESF capable of supporting owl pairs, another analysis predicted that the area that included DNR-managed lands in the OESF would be capable of supporting 80 percent more owl pairs.

Projections of each of the alternatives 100 years into the future predicted that, regardless of alternative, the spotted owl sub-population on the Olympic Peninsula would decline for approximately 60 years. After that time the population would reverse its negative trend and begin to increase in size because of the increase in habitat capability resulting from habitat development on federal lands. There were no statistically significant differences among predicted population trends under the No Action alternative or either action alternative. Projections of the Zoned Forest and Unzoned Forest alternatives 100 years into the future predicted an Olympic Peninsula spotted owl sub-population that was 2 percent and 5 percent larger, respectively, relative to projections of the No Action alternative 100 years into the future.

Estimates of the risk for incidental take of owl sites were developed for the No Action and action alternatives based on the currently known 60 spotted owl sites in the OESF area. No Action is based on avoiding risk for incidental take of owl sites, thus, by definition it avoids placing sites at risk for take. The Zoned Forest alternative was estimated to place nine sites at risk for incidental take. The Unzoned Forest alternative was estimated to place 31 sites at risk for incidental take, although an alternative analysis suggests that 24 sites could be estimated to be at risk for incidental take. It is likely that the risk to existing, but currently unknown, owl sites for incidental take under each alternative is similar to the risk estimates for known sites. Risk to future owl sites for incidental take may be relatively even among the No Action and action alternatives because the overall greater habitat capability that will result under the action alternatives will provide landscape-wide conditions that can support owls and thus minimize risk, whereas the limited number of sites that will result in the future from the No Action alternative and its risk-avoidance approach will also minimize risk.

The No Action alternative only manages to protect the (frequently inadequate, see Table 4.4.11) *status quo*. Under both action alternatives, the landscape is managed for habitat capability at broader scales with potentially much more positive outcomes for owl conservation in the OESF area. It appears that one risk to the viability of the spotted owl sub-population on the Olympic Peninsula remains under the President's Forest Plan; that resulting from a relatively restricted geographic and ecological distribution of owls and their habitat in the mid-elevation forests of the interior Olympic Peninsula. Both action alternatives are predicted to extend the geographic and ecological distribution of owls and habitat into the low-elevation, coastal plain forests in the OESF area. Predictions are that the habitat capability of this area will increase by 27 percent under the Zoned Forest alternative, and by 51 percent under the Unzoned Forest alternative.

Introduction

Three techniques are used to evaluate the alternatives: (1) an evaluation of the general habitat capability of the OESF area that will result, in the near and long term, from each alternative; (2) evaluations of the ability of the landscape to provide suitable sites for resident owls, and computer simulations of spotted owl life histories in response to landscape conditions that will result from each alternative; and, (3) the degree to which each alternative places owl sites at risk for incidental take. Techniques 1 and 2 are, in essence, analyses of the "cumulative effects" of the alternatives in that they predict the outcomes of 100 years of management under each of those alternatives. A brief summary of each evaluation technique is provided below. Appendix D provides a detailed discussion of methods. It is essential that the careful reader of these evaluations refer to Appendix D to understand the methods and assumptions underlying the results and conclusions reported here.

Methods for a general evaluation of habitat capability

Both stand- and landscape-level characteristics of forests are important to their capability as habitat for spotted owls (see Horton in press for a review). Forest stands with a particular structure and composition have been defined as either young- or old-forest spotted owl habitat in western Washington (see Hanson et al. 1993). Stands with these characteristics have been otherwise variously classified as small sawtimber, large sawtimber, and old growth (Brown 1985) or young, mature and old growth (Spies and Franklin 1991). An estimate of the current amount and distribution of forest stands of these types, in the OESF area, has been derived from analysis of Landsat Thematic Mapper satellite imagery (WDFW 1994b, Map 26 and Table 4.4.8). Projections of future amounts and distributions of these stand-types under the alternatives can be based on: (1) the relationships among stand age, structure, and composition; and, (2) succession and harvest patterns under the alternatives, and other assumptions about land use. These estimates of current and likely future landscape conditions can then be used to evaluate the capability of current and likely future landscapes as habitat for spotted owl pairs. Analyses were conducted at the scale of pair ranges, approximated by a circle of 2.7 miles radius (Holthausen et al. 1994). The methods and assumptions used for the analyses reported here are described in Appendix D.

Methods for conducting computer simulations of spotted owl life histories
Schumaker (1995) provides a detailed description of the simulation model. The simulation model is designed to be used with raster GIS data showing the spatial distribution of habitat, and consists of three separate modules that conduct habitat analysis, movement simulation, and demographic simulation. The habitat analysis module is used to generate a data file that specifies the locations and qualities of hexagon-shaped units of land cover. The resulting data are used in both the movement and demographic simulations. The movement module is individual-based, and simulates the dispersal of fledglings and the seasonal wandering of floaters. A key feature of the demographic module is the ability to link certain life history parameters -- survivorship, fecundity, and site fidelity -- to habitat quality. An owl surrounded by high habitat is less likely to disperse, more likely to survive, and more likely to produce a large brood. Results of modeling can then be used to estimate habitat capability of both current and likely future landscapes, as well as to estimate spotted owl population size, trends, and distribution in the future. The methods and assumptions used for the analyses reported here are described in Appendix D.

Methods for estimating incidental take of spotted owls
It is anticipated that during the life of the HCP, some spotted owls may be displaced, and habitat conditions for some individual owls or owl pairs may be degraded by DNR activities in the OESF such that their ranges are temporarily incapable of supporting them. These activities will constitute incidental take of spotted owls as defined by the ESA. The degree to which each alternative either avoids or allows incidental take is another method for comparing those alternatives. The evaluation criteria of the USFWS to estimate the risk of incidental take (Frederick 1994) were used for these analyses. Their criteria are based on maintaining a threshold proportion of habitat in home range-sized circles around known owl sites as defined by the WDFW. The methods and assumptions used for the analyses reported here are described in Appendix D.

Evaluation Criterion 1 - Abundance and Distribution of Habitat

Evaluations of the current and likely future abundance and distribution of spotted owl habitat were based on results of two analysis methods described above, the habitat capability method (Appendix D) and the simulation model (Schumaker 1995: Appendix D).

Evaluations based on Habitat Capability Estimates

Current Habitat Conditions

Current conditions were estimated to provide 338,900 acres on all ownerships and 48,900 of the 270,000 DNR-managed acres within the 1,066,300-acre OESF area that had at least 40 percent potential habitat at the scale of pair ranges (Figure 4.4.7a, Table 4.4.9). That suggests that 32 percent of the total area and 18 percent of DNR-managed land within the

OESF area is currently capable of supporting owl pairs. That percentage can be used as a base line against which to evaluate the conservation benefits of the No Action, the Zoned Forest, and Unzoned Forest alternatives.

ALTERNATIVE 1

Projections of the No Action alternative 100 years into the future resulted in 359,600 acres on all ownerships and 36,800 DNR-managed acres within the analysis window that had at least 40 percent potential habitat at the scale of pair ranges (Figure 4.4.7b, Table 4.4.9). Under the No Action alternative, the habitat capability of the overall OESF area is predicted to improve such that 34 percent of the land area will be capable of supporting owl pairs, but the habitat capability of DNR-managed lands is predicted to decline such that only 14 percent could support owl pairs (see Appendix D). The overall improvement in habitat capability within the approximately 1-million-acre OESF area is predicted to result from habitat development on the Olympic National Forest resulting from current policy (USDA and USDI 1994a). The decline in habitat capability on DNR-managed lands will result from a predicted redistribution of habitat, even though the overall proportion of habitat on DNR-managed land is predicted to remain constant (Appendix D). The predicted outcomes of the No Action alternative can be used as another basis for evaluation of the conservation benefits of the action alternatives.

ALTERNATIVE 2

Projections of the Unzoned Forest alternative 100 years into the future resulted in 511,300 acres on all ownerships and 153,600 acres of DNR-managed land in the OESF area that had at least 40 percent potential habitat at the scale of pair ranges (Figure 4.4.7d, Table 4.4.9). Under the Unzoned Forest alternative, the habitat capability of the OESF area is predicted to improve such that 48 percent of all and 57 percent of DNR-managed lands will be capable of supporting owl pairs. This improvement in habitat capability is predicted to result from: habitat development on all DNR-managed lands in the OESF under the Unzoned Forest alternative, habitat development on the Olympic National Forest resulting from current policy (USDA and USDI 1994a), and generally static habitat conditions on other lands.

The Unzoned Forest alternative is predicted to provide substantially more habitat capability, on DNR-managed lands and across the OESF, in 100 years than either current conditions or than under the No Action alternative in 100 years. A greater than three-fold increase in habitat capability relative to current conditions on DNR-managed lands is predicted under the Unzoned Forest alternative, while the capability of the entire OESF area should increase by 51 percent (Table 4.4.9).

The Unzoned Forest alternative produces a greater than four-fold increase in the capability of DNR-managed lands as habitat for spotted owls than does the No Action alternative (Table 4.4.9). A long-term, 42 percent increase in habitat capability of the entire OESF area is also predicted relative to no action (Table 4.4.9). The Unzoned Forest alternative is predicted to provide the greatest long-term increases in habitat capability among all alternatives.

ALTERNATIVE 3

Projections of the Zoned Forest alternative 100 years into the future resulted in 429,600 acres on all ownerships and 97,200 acres of DNR-managed land in the OESF that had at least 40 percent potential habitat at the scale of pair ranges (Figure 4.4.7c, Table 4.4.9). Under the Zoned Forest alternative, the habitat capability of the OESF area is predicted to improve such that 40 percent of all and 36 percent of DNR-managed lands will be capable of supporting owl pairs. This improvement in habitat capability is predicted to result from: habitat development on some DNR-managed lands (the owl zones) under the Zoned Forest alternative for the OESF, habitat development on the Olympic National Forest resulting from current policy (USDA and USDI 1994a), generally static habitat conditions on other DNR-managed lands (outside the owl zones), and generally static conditions on other lands.

The Zoned Forest alternative is predicted to provide substantially more habitat capability, on DNR-managed lands and across the OESF, in 100 years than either current conditions or than under the No Action alternative in 100 years. Under this alternative, the habitat capability of DNR-managed lands is predicted to nearly double relative to current conditions while the capability of the entire area should increase by 27 percent (Table 4.4.9). The Zoned Forest alternative produces a greater than two-fold increase in the capability of DNR-managed lands as habitat for spotted owls than does the No Action alternative (Table 4.4.9). A long-term, 19 percent increase in habitat capability of the entire OESF area is also predicted relative to the No Action alternative (Table 4.4.9).

Evaluations based on the Simulation Model

Current Habitat Conditions

Figure 4.4.8 shows the hexagonal habitat map developed for the current conditions on the Olympic Peninsula. The two-dimensional pattern reflects model predictions of sites suitable and unsuitable for occupancy by owl pairs (Appendix D). The suitable sites (dark gray hexagons) on the mostly federal lands are surrounded by unsuitable sites (light gray hexagons) on mostly state-managed and private lands. A "hole" in the center of the federal ownership is created by the nonforested subalpine and alpine areas of the Olympic Mountains. In the highest portions of the mountain range these areas act as barriers to owl movement (black hexagons). The pattern of suitable sites approximates the known distribution of many spotted owl sites. For example, suitable sites along the west coast of the peninsula match areas of known occupancy by spotted owl pairs in the coastal strip of Olympic National Park. The Queets River corridor of the park is seen to extend in a southwesterly direction from the habitat doughnut. The large block of suitable sites extending westward in the northwestern portion of the doughnut corresponds with many known sites on federal lands in the Calawah and Bogachiel watersheds. The Clallam River area, in the northwest corner of the peninsula, contains three suitable sites oriented in a horizontal strip. A pair of owls is known to inhabit this area.

The habitat model partitioned the Olympic Peninsula into 1,239 hexagonal, 3,134-acre sites, of which 435 were classified as suitable (Table 4.4.10). A suitable site is one in which the quality and quantity of habitat within it, or within it and its adjacent sites, is adequate to support a nesting pair of spotted owls (Appendix D). One hundred seventy-two suitable sites had scores greater than five, the suitable site threshold. Those suitable sites with scores less than five were classified as suitable because of available habitat in adjacent sites. The distribution of site scores resembled an exponential distribution, but suitable site scores were normally distributed (Figure 4.4.9). Suitable sites scores ranged from 0.248 to 8.99, and the median score equaled 4.4 (Table 4.4.10). Two hundred thirty-four sites, of which 61 were classified as suitable, contained some DNR-managed lands in the OESF (Table 4.4.10). Twenty-seven sites, of which nine were classified as suitable, contained more than 90 percent DNR-managed lands in the OESF (Table 4.4.10).

ALTERNATIVE 1

Over the next 100 years, under the No Action alternative, habitat development on federal lands is predicted to increase the number of suitable sites from 435 to 470 (Table 4.4.11, Figure 4.4.10). Two hundred twenty-five of these suitable sites had scores greater than the suitable site threshold, and the median suitable site score increased to 4.8 (Table 4.4.11). The average score of sites classified as unsuitable for spotted owl nesting also increased. In the population simulations, unsuitable sites can be occupied by floaters, and therefore, survivorship of floaters increases with habitat quality at these sites (Appendix D). Relative to current conditions, DNR's forest management under the No Action alternative did not contribute to the development of additional suitable sites, nor did the median score of sites with greater than 90 percent DNR-managed land change (Tables 4.4.10, 4.4.12).

The No Action alternative does not result in an appreciable change in the predicted spatial distribution of suitable sites in the OESF area (Figure 4.4.11).

ALTERNATIVE 2

Habitat development on DNR-managed lands under the Unzoned Forest alternative, relative to the No Action alternative, is predicted to increase the number of suitable sites by 35 to a total of 505 (Table 4.4.11, Figure 4.4.10). This effect was not confined to DNR-managed lands, as the number of suitable sites with some DNR-managed lands increased by 32 relative to the No Action alternative (Table 4.4.11). Habitat development on DNR-managed lands thus increased the number of suitable sites on some adjacent federal lands as well (Appendix D). Habitat quality on DNR-managed lands, as reflected by the median score of suitable sites with greater than 90 percent DNR-managed lands, increased more than 2.5 times relative to No Action (Table 4.4.11). The quality and quantity of habitat on DNR-managed lands increased their capability as habitat such that 89 percent (24 of 27) of sites with greater than 90 percent DNR-managed lands were suitable (Table 4.4.11). Similar to the No Action alternative, the average score of all sites increased with similar, positive results for the survivorship of non-territorial owls.

The Unzoned Forest alternative resulted in a noticeable increase in the numbers and density of suitable sites west of the core of federal ownership in the OESF area, beginning in 60 years (Figure 4.4.13). DNR's management under this alternative resulted in the westward extension of suitable sites from the federal core towards the Olympic National Park coastal strip. Suitable sites also develop in the northwest portion of the peninsula because of concentrations of DNR-managed lands there. Extended model runs that allowed predictions of occupancy of suitable sites by territorial owls and both suitable and unsuitable sites by non-territorial owls showed an appreciable change in the spatial distribution of occupied sites. Under the No Action alternative, 502 sites were predicted to receive some occupancy compared to 559 sites for the Unzoned Forest alternative. The most westerly portion of the Olympic Peninsula is dominated by nonfederal lands and can be approximated by the westernmost set of sites that include two-thirds of the sites with some DNR-managed lands. Relative to the No Action alternative (56 sites with some occupancy), there was a nearly two-fold increase in the numbers of sites that were occupied at some time during the model runs in this portion of the peninsula (101 sites). Nearly all the increase in occupancy, peninsula-wide, occurred in this portion of the peninsula under the Unzoned Forest alternative (45 of 57 more sites with some occupancy).

ALTERNATIVE 3

Habitat development on DNR-managed lands under the Zoned Forest alternative, relative to the No Action alternative, is predicted to increase the number of suitable sites by 29 to a total of 499 (Table 4.4.11, Figure 4.4.10). This effect was not confined to DNR-managed lands, as the number of suitable sites with some DNR-managed lands increased by just 25 relative to the No Action alternative (Table 4.4.11). Habitat development on DNR-managed lands thus increased the number of suitable sites on some adjacent federal lands. Habitat quality on DNR-managed lands, as reflected by the median score of suitable sites with greater than 90 percent DNR-managed lands, increased 2.5 times relative to No Action (Table 4.4.11). The quality and quantity of habitat on DNR-managed lands increased their capability as habitat such that 78 percent (21 of 27) of sites with greater than 90 percent DNR-managed lands were suitable (Table 4.4.11). Similar to the No Action alternative, the average score of all sites increased with similar, positive results for the survivorship of non-territorial owls.

The Zoned Forest alternative resulted in a noticeable increase in the numbers and density of suitable sites west of the core of federal ownership in the OESF area, beginning in 60 years (Figure 4.4.12). DNR's management under this action alternative resulted in the predicted westward extension of suitable sites from the federal core towards the Olympic National Park coastal strip. Suitable sites also develop in the northwest portion of the peninsula because of concentrations of DNR-managed lands there. Extended model runs that allowed predictions of occupancy of suitable sites by territorial owls and both suitable and unsuitable sites by non-territorial owls showed an appreciable change in the spatial distribution of occupied sites. Under the No Action alternative, 502 sites were predicted to receive some occupancy compared to 553 sites for the Zoned Forest alternative. The most westerly portion of the Olympic Peninsula is dominated by nonfederal lands and can be approximated by the westernmost set of sites that include two-thirds of the sites with some DNR-managed lands. Relative to the No Action alternative (56 sites with some occupancy), there was a nearly two-fold increase in the numbers of sites that were occupied at some time during the model runs in this portion of the peninsula (98 sites). Nearly all the increase in occupancy, peninsula-wide, occurred in this portion of the peninsula under this action alternative (42 of 51 more sites with some occupancy).

Evaluation Criterion 2 - Population Trends

Projected Population Trends

Numbers of spotted owl pairs on the Olympic Peninsula are predicted to decrease for 60 years based on model assumptions (Appendix D) and current habitat conditions (Figure 4.4.14). Projected habitat development on federal lands and under the OESF action alternatives were not able to reverse this trend under the most conservative set of model assumptions (juvenile survivorship of 0.41, Figure 4.4.14). But under the other sets of model assumptions (juvenile survivorship of 0.47 and 0.53), numbers of owl pairs were predicted to begin increasing after 60 years (Figure 4.4.14). Trends were similar for the No Action and both action alternatives; thus population trends were primarily due to habitat development on federal lands. Neither the No Action or the action alternatives for the OESF were predicted to have much effect on the overall size of the Olympic Peninsula sub-population in the future (Figure 4.4.14). Assumptions about juvenile survivorship did not alter this basic finding. Model runs projected 10 more pairs resulting from the Zoned Forest alternative (2 percent more overall) and 20 more pairs from the Unzoned Forest alternative (5 percent more overall) in 100 years, relative to the No Action alternative.

The model predicts fewer owl pairs than suitable sites over the long term. This relationship of populations to habitat is believed to occur in natural populations that occur in heterogenous environments, due to the responses of populations to habitat quality (e.g., Brown 1969; Fretwell and Lucas 1969; Pulliam 1988). These relationships of population size and distribution with the quality, abundance, and distribution of suitable sites are also apparent in model projections. A fuller explanation of this theoretical construct is developed by Wilhere et al. (in prep.); suffice it to say that all suitable sites will never be occupied, and that the ratio of occupied sites to unoccupied sites is a function of habitat-dependent demographic parameters and the spatial arrangement of habitat.

A dramatic change occurs at year 60 in the population trajectories predicted by model runs with juvenile survivorship values of 0.47 or 0.53 (Figure 4.4.14). From year 0 to year 59 the population is steadily declining, and from year 60 on this trend is reversed. This abrupt change is the result of simulated population responses to current landscape characteristics and assumptions about forest succession used to develop habitat maps (Table 4.4.8 and Appendix D). The 60-year future landscapes see all large sawtimber, which was assigned the median class age of 150 years, become old growth and all recent clearcuts become small sawtimber (Appendix D), each resulting in increased value as habitat (Appendix D). While incremental increases in the numbers of suitable sites occur in the 20- and 40-year habitat maps (Figure 4.4.10), numbers of high-quality sites do not change until year 60 and nearly half of the overall increase in numbers of suitable sites occurs between the 40- and 60-year habitat maps. It is the population response to that stepwise increase in habitat quality and quantity that produces the reversal in the simulated, declining Olympic Peninsula sub-population.

Evaluation Criterion 3 - Estimates of the Risk for Incidental Take of Spotted Owl Sites

There are 69 owl sites within 2.7 miles of DNR-managed land in the OESF (WDFW 1995c). Washington Department of Fish and Wildlife assigned these sites a status based on the nature of the observations recorded there: 45 are classified as pair sites, two as sites occupied by two owls of unknown pair status, 13 territorial single sites, and nine sites where owls were observed but could not be assigned a resident status. A more complete discussion and definition of the concept of incidental take is provided elsewhere in this DEIS, however, a summary follows. Incidental take could result from either the harm or harassment of owls (60 Fed. Reg. 9484 (1995)). Harassment would occur when pairs or territorial single owls were disturbed at activity centers (60 Fed. Reg. 9484 (1995)), while harm would result from significant habitat removal around site centers (60 Fed. Reg. 9484 (1995)). Site centers are defined as the nest or activity center of pairs or territorial single owls (60 Fed. Reg. 9484 (1995)). Thus, take could occur from harm or harassment of pairs, two owls of unknown pair status, or territorial singles of which a total of 60 site centers are known from within 2.7 miles of DNR-managed land in the OESF. Estimates of take under each alternative are based on potential DNR harvests of owl habitat either within 2.7 mile radius circles around those site centers in which habitat comprises 40 percent or less land cover, or within 0.7-mile radius circles around those site centers in which habitat comprises 50 percent or less land cover (Frederick 1994). In analyzing the effects of potential harvests within 0.7 miles of site centers, estimates of incidental take in the OESF differ from analyses for the other HCP planning units because the limited geographic scope of the problem allowed more detailed analyses.

Estimates of the Risk for Incidental Take at Known Spotted Owl Sites

ALTERNATIVE 1

The No Action alternative would avoid incidental take by deferring harvest of habitat in circles with 40 percent or less habitat. In fact, recent DNR policy has been to avoid harvest of potential owl habitat throughout the OESF area in anticipation of an HCP or HCP-like agreement. It is reasonable to assume that if no such agreement is reached, DNR harvests of potential owl habitat would proceed after owl surveys located areas in which such harvests could be conducted without risk of incidental take. Those areas would be habitat farther than 2.7 miles from site centers, including areas formerly occupied by owls but demonstrated through surveys to be abandoned; and habitat within 2.7 miles of site centers with more than 40 percent habitat.

The No Action alternative can thus be said to avoid placing known owl sites at risk for incidental take. However, it should be noted that many of those known sites were already at risk of being unable to support resident owls (because more than 40 percent of the surrounding habitat had been harvested) when the owl was listed in 1990. Thus, while the No Action alternative nominally avoids risk of incidental take, the risk that many of those sites are incapable of supporting resident owls remains.

ALTERNATIVE 2

The Unzoned Forest alternative is based on managing all landscapes in the OESF to maintain or restore threshold proportions of owl habitat (Chapter 2). However, harvests of some owl habitat may occur without regard for current landscape conditions in anticipation of habitat development in those landscapes (those harvests are predicted to occur in the first 40-60 years of management under the alternative). Throughout the life of an HCP under this alternative, harvests of habitat would proceed under the guidance of general, landscape-level management plans and without regard for then-current locations of owl sites (Chapter 2). Those harvests could result in incidental take. However, habitat capability would increase across the OESF for most of the life of an HCP under this alternative until stabilizing a much higher level than currently exists. Levels of take after the first 40-60 years would likely be lower because of the greater habitat capability that would result on DNR-managed lands and across all ownerships on the OESF, i.e., landscape-level abundance of potential owl habitat would frequently exceed 50 percent (Figure 1d, Appendix D).

Estimates of habitat and land ownership around owl site centers were used to classify these sites for estimates of the potential for incidental take under the Unzoned Forest alternative for the OESF (Table 4.4.13). DNR-managed habitat provides the margin above 40 percent at 11 site centers (Table 4.4.13), thus there is some potential that DNR harvests could result in take at these sites. One site is peripheral to the OESF; less than 1 percent of the habitat is within DNR-managed lands in the OESF although 8 percent of the habitat is on other DNR-managed lands. The Unzoned Forest proposal for the OESF can not put this site at risk for incidental take. This site could potentially be taken under either HCP action alternative for other DNR-managed lands and is discussed in Chapter 4.2.1. Six of these 11 sites have at least 30 percent habitat on federal lands, overall habitat of at least 50 percent, and current estimates of harvest patterns under the Unzoned Forest alternative suggest that habitat will remain above 40 percent around each of these sites. Thus, these sites should not be considered at risk for take under this alternative. In total, four of the 11 site centers at which DNR-managed habitat provides the margin above 40 percent are at risk for take under the Unzoned Forest alternative for the OESF.

Thirty-one site centers within 2.7 miles of DNR-managed lands in the OESF are estimated to have less than 40 percent cover of potential habitat within their circles. Any DNR harvest of habitat within those circles could put owls at risk for incidental take. However, four of those sites are far from concentrations of DNR-managed lands and habitat on DNR-managed lands is estimated to cover from none to less than 1 percent of the circles around those sites. It is reasonable to conclude that these sites should not be considered at risk for take under the Unzoned Forest alternative. Thus, 27 of the 31 site centers surrounded by less than 40 percent habitat should be considered to be at risk for take under the Unzoned Forest alternative for the OESF.

In summary, the simplest estimate is that 31 of the 60 site centers within 2.7 miles of DNR-managed lands in the OESF are at risk for take under the Unzoned Forest alternative. Those not at risk for take are: 18 site centers with greater than or equal to 40 percent habitat on federal land; seven sites with greater than or equal to 40 percent habitat on all ownerships, and at which DNR harvests in the OESF are estimated to maintain greater than or equal to 40 percent habitat on federal and DNR-managed land; and four sites with less than 1 percent habitat on DNR-managed land in the OESF.

Additional information can be used to refine the simple estimate derived above, the habitat conditions around sites and the recent history of observations at sites. This information allows inferences about the likelihood that sites can actually support resident owls and the recent occupancy of sites, and thus, refined estimates of the risk of actually taking real owls. Eleven sites that are considered above to be at risk for take under the

Unzoned Forest alternative are surrounded by less than 20 percent habitat, a level which is associated with significantly lower occupancy (Bart and Forsman 1992). Four of the 11 sites are in the coastal strip of Olympic National Park and have received only sporadic owl surveys. There are insufficient data with which to infer occupancy rates at those sites. The other seven sites are on DNR-managed lands in the OESF and are surrounded by state, federal, and private lands. They have been monitored regularly by biologists from state and federal agencies and private consulting firms since 1991 or 1992. No spotted owls have been found at six of those sites since 1993, and a single owl was observed on one visit only in 1995 at a site where no owls had been detected since 1991. It is reasonable to infer that these seven sites are not currently occupied by resident owls because they have insufficient habitat to support residents, and owls do not appear to be currently residing at these sites. Thus, a refined estimate of the number of sites that appear to have the potential to support resident owls, and/or may currently support resident owls, and that should be considered to be at risk for take under the Unzoned Forest alternative for the OESF is 24 sites. These 24 sites thus estimated to be at risk for take should be considered a legitimate alternative estimate to the 31 sites identified in the simple estimate above.

ALTERNATIVE 3

The Zoned Forest alternative is based on delineating areas (owl zones) in which management for the retention and restoration of owl habitat until threshold proportions are attained (predicted to be in 40-60 years) is a priority (Map 26, and see Chapter 2). An additional feature of this alternative is the designation of several high priority areas (approximated by current owl circles, Map 27) for interim conservation of owl habitat (until threshold proportions are attained in the owl zones). Harvests of habitat would be deferred for 40-60 years within the owl zones, as well as the interim conservation areas. To the extent that boundaries of the owl zones and current, high priority owl circles coincide with boundaries of owl circles over the deferral period, then incidental take would be avoided within those circles. Take could occur in circles whose boundaries are not entirely within the zones or interim protection areas. After threshold proportions of habitat are attained, harvests of habitat would proceed under the guidance of more general, landscape-level management plans and without regard to then-current locations of owl sites. But the overall level of take would likely be lower then because of the greater habitat capability that would result on DNR-managed lands and across all ownerships in the OESF, i.e., landscape-level abundance of potential owl habitat would frequently exceed 50 percent (Figure 1c, Appendix D).

Estimates of habitat and land ownership around owl site centers were used to classify these sites for estimates of the potential for incidental take under the Zoned Forest alternative for the OESF (Table 4.4.12). Some potential exists for incidental take of eight pair and four single sites during the first 40-60 years of management under this alternative (Table 4.4.12). The potential for lower levels of take exists after that time as described above. DNR-managed habitat provides the margin above 40 percent at four of the eight pair sites away from owl zones or high priority circles (Table 4.4.12), thus there is some potential that DNR harvests could result in take at these site centers. One of these four sites is peripheral to the OESF; less than 1 percent of the habitat is within DNR-managed lands in the OESF, although 8 percent of the habitat is on other DNR-managed lands.

The Zoned Forest proposal for the OESF can not put this site at risk of incidental take. This site could potentially be taken under either HCP action alternative for other DNR-managed lands and is discussed in Chapter 4.2.1. One additional pair site has at least 30 percent habitat on federal lands, overall habitat of at least 50 percent, and current estimates of harvest patterns under the Zoned Forest alternative suggest that habitat will remain above 40 percent around this site. Thus, these two sites should not be considered at risk for take under this alternative. In total, two of the four pair sites at which DNR-managed habitat provides the margin above 40 percent are at risk for take under the Zoned Forest alternative for the OESF.

The other eight site centers (four pair and four single territorial sites) within 2.7 miles of DNR-managed lands in the OESF are estimated to have less than 40 percent cover of potential habitat within their circles and are located away from owl zones or high priority sites under the Zoned Forest alternative (Table 4.4.12). Any DNR harvest of habitat within those circles would put owls at risk for incidental take. However, one of those sites is far from concentrations of DNR-managed lands and habitat on DNR-managed lands is estimated to cover less than 1 percent of its circle. It is reasonable to conclude that this site should not be considered at risk for take under the Zoned Forest alternative. Thus, seven of the eight site centers surrounded by less than 40 percent habitat should be considered to be at risk for take under the Zoned Forest alternative for the OESF. In total, nine of the 60 site centers within 2.7 miles of DNR-managed land in the OESF should be considered at risk for take under the Zoned Forest alternative.

Estimates of the Risk for Incidental Take at Spotted Owl Sites as yet Unknown

Incidental take of owls that are not yet known will also occur under all alternatives for the OESF. Two types of situations describe these owls: those that currently live within 2.7 miles of DNR-managed lands in the OESF but have not been discovered; and owls that in the future, during the period of the HCP, will live within 2.7 miles of DNR-managed lands in the OESF. An estimate of the numbers of nearby, but unknown, owls can be developed by increasing the number of sites on DNR-managed, private, and Olympic National Forest lands by 10 percent (after Holthausen et al. 1994), and increasing the numbers of sites on Olympic National Park by a much greater, although unknown, number because those lands have not been thoroughly surveyed (Holthausen et al. 1994). There are 48 known site centers on Olympic National Forest and nonfederal lands, plus 10 percent gives an estimate of 53 site centers. Olympic National Park contains 12 site centers within 2.7 miles of the OESF; doubling that number may provide a reasonable estimate of 24 site centers. Thus there are an estimated 77 current site centers (compared to 60 known site centers) that could be within 2.7 miles of DNR-managed lands in the OESF. It also may be reasonable to assume that those sites are distributed with respect to land ownership patterns and habitat amounts such that the proportions of sites that are and are not at risk for take under the three alternatives are similar to those estimated for known sites. Thus, the risk for incidental take of unknown owls may be lowest in the near term for the No Action alternative, slightly greater for the Zoned Forest alternative, and highest for the Unzoned Forest alternative.

It is difficult to estimate the numbers of owls that will, in the future, be at risk for take under the three alternatives for the OESF. Part of that uncertainty is because the numbers and locations of resident owls over the course of the proposed HCP are unknown. Assuming that conditions for owls will improve over time as habitat restoration proceeds under federal land management plans, variously change over time under the three alternatives, and that the Olympic Peninsula sub-population will be reasonably stable, then the OESF area will likely be inhabited by a fairly constant number of resident owls that varies with the habitat provided by each alternative. Habitat in the OESF area is predicted to support increasingly more resident owls from the No Action, to the Zoned Forest, to the Unzoned Forest alternative. Those owls will inhabit sites that move both in response to patterns of forest growth and harvest, and in response to other characteristics of owl behavior and ecology. It may be that risk for take at these future owl sites will be related to the abundance of sites, because harvests may displace resident owls and more resident owls are likely if more suitable sites are available. But it is likely that such displacement in landscapes with relatively abundant habitat would have much less detrimental effects on those owls than in landscapes in which habitat capability is critically low, such as the current OESF landscape or the predicted future landscape under the No Action alternative. Thus, it may be that the risk for incidental take at future owl sites is relatively even among the No Action and action alternatives.

Summary and Comparison of the Alternatives

It is important to directly compare the characteristics of the action alternatives to the No Action alternative as they relate to the threats to spotted owls discussed above. The No Action alternative only manages to protect the (frequently inadequate, see Tables 4.4.12, 4.4.13) *status quo* around relatively geographically-fixed owl site centers, thus ensuring that regulatory incidental take is unlikely. Under both action alternatives, the landscape is managed for habitat capability at broader scales with potentially much more positive outcomes for owl conservation in the OESF area. This distinction between the No Action and action alternatives is manifest in an examination of the effects each alternative has on threats to the viability of spotted owls on the Olympic Peninsula.

Population Size and Trends

Segments of the owl population on the Olympic Peninsula are almost certainly not at equilibrium with their environment, as habitat has been removed more rapidly than the long-lived, site-faithful territory-holders relinquish occupancy of their territories. Even without further removals of owl habitat, segments of the population may continue to decline to a new equilibrium with the available habitat (Thomas et al. 1990). This is suggested by the recent (over the past 4 years) loss of formerly reproductive owl pairs from several sites on DNR-managed lands around which most habitat was removed before the sites were protected following the listing of the owl in 1990. And, it is apparent in the predictions of two independent modeling efforts (Figure 4.4.14; Holthausen et al. 1994). Occupancy rates of other marginal sites on or near DNR-managed lands in the OESF will probably decline further, at least until habitat capability begins to recover.

No Action and Action Alternatives

Further reductions in numbers of owls occupying marginal sites are likely under all alternatives (Figure 4.4.14). It is possible that additional reductions in habitat capability could exacerbate declines at some marginal sites, perhaps more so with increasing harvest of habitat (as under either action alternative). This prediction, however, could not be demonstrated by modeling. There were no statistically significant differences among the predicted numbers of owl pairs for either action alternative, No Action, or for a static landscape (Wilhere et al. in prep.) during the continued, predicted population declines that persist for 60 years (Figure 4.4.14).

Rates of habitat development significantly exceed rates of harvest of habitat under both action alternatives for the OESF. For example, Table 4.4.14 shows trends in habitat over time from an exploratory analysis of the outcomes of potential management scenarios under the Unzoned Forest alternative for the OESF (Martin 1995). Very small interim reductions in old-forest habitat are accompanied by very large increases in young-forest habitat with long-term increases in both young- and old-forest habitat. Numbers of suitable sites predicted by modeling begin to increase immediately for each action alternative, relative to the No Action alternative. Population modeling predicts a very slight gain, 2 percent to 5 percent, in overall numbers of owl pairs on the Olympic Peninsula for the Zoned and Unzoned Forest alternatives, respectively, relative to the No Action alternative. Each OESF alternative differs in the degree to which it protects or enhances habitat capability on and near DNR-managed lands in the OESF and thus, numbers of owls on the Olympic Peninsula. However, given the current estimates of a fairly sizable sub-population on the Olympic Peninsula (Holthausen et al. 1994) and predictions of a fairly sizable sub-population in the future (Figure 4.4.14; Holthausen et al. 1994), it may be that those relatively small differences on a peninsula-wide scale are not important.

The effects of the alternatives on population trends are likely to resemble those on population size. Owls on or near DNR-managed lands were incorporated into the banding studies approximately in proportion to their abundance in the sub-population, so the distinct sets of habitat conditions they experienced are represented in the analyses derived from those data. Simulation modeling predicts that population trends for spotted owls on the Olympic Peninsula are independent of the alternatives for the OESF (Figure 4.4.14). Habitat conditions on the much larger area of federal lands on the Olympic Peninsula are the most important factor affecting the viability of the sub-population. Given the current conditions of habitat on the Olympic Peninsula and model assumptions, the spotted owl population may continue to decline for several decades. Then, under the President's Forest Plan, peninsula-wide habitat conditions are predicted to reach a state that supports a viable population. Holthausen et al. (1994) concurred, and concluded that, regardless of habitat conditions on nonfederal lands "...it is likely, but not assured that a stable population would be maintained..." on portions of the federal lands at the core of the Olympic Peninsula. Thus, it appears that neither near- or longer term trends in the size of the sub-population will change as the result of any of either the No Action or action alternatives for the OESF.

Geographic and Ecological Distribution of Owls and Habitat

Threats to the viability of owls on the peninsula resulting from a restricted geographic and ecological distribution would remain if owls only inhabited the mid-elevation forests in the federal lands. Holthausen et al. (1994) concluded that "...a biologically significant contribution..." could result from maintaining a more widely distributed, stable population of owls.

ALTERNATIVE 1

Projections of the No Action alternative 100 years into the future predict no change in the geographic and ecological distribution of owls and their habitat relative to the current condition (Figure 4.4.7a-d, 4.4.11, 4.4.12, 4.4.13; and Tables 4.4.9, 4.4.10, and 4.4.11).

ALTERNATIVE 2

The Unzoned Forest alternative contributes to the broadest geographic and ecological distribution of owls and their habitat relative to either the current condition, the No Action alternative, or the Zoned Forest alternative projected into the future (Figures 4.4.7a-d, 4.4.11, 4.4.12, and 4.4.13; and Tables 4.4.9, 4.4.10, and 4.4.11). The density of predicted, suitable sites on and around DNR-managed lands west of the mid-elevation, federally-owned core of the Olympic Peninsula slowly increases over the first 40 years of this alternative, then more rapidly after 60 years (Figure 4.4.13). The Unzoned Forest alternative contributes appreciably to the overall habitat capability of mostly the lower elevation, coastal plain forests in the OESF, adding 51 percent to the current, overall habitat capability in this area (Figures 4.4.7a,b,d, Table 4.4.9), and resulting in a greater than three-fold increase in the habitat capability of DNR-managed lands (Figures 4.4.7a,b,d; Table 4.4.9). Under this alternative, areas of capable habitat extend increasingly farther from the federal lands at the core of the Olympics (Figures 4.4.7a,b,d, 4.4.11, and 4.4.13). It may be that the most significant contribution of the Unzoned Forest alternative to spotted owl conservation would result from its substantial increase in the geographic and ecological distribution of owls and their habitat on the Olympic Peninsula.

ALTERNATIVE 3

The Zoned Forest alternative contributes to a broader geographic and ecological distribution of owls and their habitat relative to either the current condition, or the No Action alternative projected into the future (Figures 4.4.7a,b,c, 4.4.11, 4.4.12, 4.4.13; and Tables 4.4.9, 4.4.10, and 4.4.11). The density of predicted, suitable sites on and around DNR-managed lands west of the mid-elevation, federally-owned core of the Olympic Peninsula slowly increases over the first 40 years of this alternative, then more rapidly after 60 years (Figure 4.4.12). The Zoned Forest alternative contributes appreciably to the overall habitat capability of mostly the lower elevation, coastal plain forests in the OESF, adding 27 percent to the current, overall habitat capability in this area (Figures 4.4.7a,b,c, Table 4.4.9), and resulting in a nearly two-fold increase in the habitat capability of DNR-managed lands (Figures 4.4.7a,b,c, Table 4.4.9). Under this alternative, areas of capable habitat extend increasingly farther from the federal lands at the core of the Olympics (Figures 4.4.7a,b,c, 4.4.11, and 4.4.12). It may be that the most significant contribution of the Zoned Forest alternative to spotted owl conservation would result from increasing the geographic and ecological distribution of owls and their habitat on the Olympic Peninsula.

Population Isolation
None of the alternatives considered for the OESF can be considered to significantly influence risks to the viability of owls on the Olympic Peninsula based on their demographic isolation from other sub-populations.

Natural Disturbances
As the abundant young stands on DNR-managed lands in the wind-prone areas of the OESF mature, they will increasingly function as owl habitat and become increasingly prone to windthrow. Silviculture in the OESF is anticipated to increasingly focus on retention of structural and compositional elements at harvest, in order to support ecological functions (such as owl habitat) in those stands. Windthrow is anticipated to be a challenge to forest managers in the OESF, and it is anticipated that considerable effort will be devoted to learning techniques to minimize wind damage. It can be argued that the Unzoned Forest alternative is at risk numerically to the most wind damage, because it attempts to manage for the most owl habitat in the wind-prone coastal plain areas and because it attempts to experiment with more novel silvicultural prescriptions in which retention of wind-prone structural elements are important. However, the other alternatives only incur less risk because they intend less aggressive habitat restoration.

Barred Owls
It is uncertain the degree to which barred owls will continue to increase in abundance on the Olympic Peninsula, and the degree to which they might interact with spotted owls to the detriment of the viability of spotted owls on the Olympic Peninsula. However, it can be argued that either action alternative for the OESF (because of their emphasis on research and monitoring) might be more likely to detect such interactions, learn, and implement management strategies to deal with them.

Table 4.4.8: Estimates of forest cover on lands of different ownership in the Olympic Experimental State Forest, July 1991[1]

Landowner	Cover-type	Total Area (acres)	Percent of Area[2]	Percent of Cover-type[3]
Olympic National Park	late seral[4]	216,137	16.5	59.1
	mid-seral[5]	16,298	1.2	18.7
	other[6]	143,857	11.0	16.8
Olympic National Forest	late seral	66,325	5.0	18.1
	mid-seral	15,434	1.2	17.7
	other	93,294	7.1	10.9
DNR-managed, OESF[7]	late seral	52,150	4.0	14.3
	mid-seral	20,990	1.6	24.1
	other	197,974	15.1	23.1
Other[8]	late seral	30,983	2.4	8.4
	mid-seral	34,293	2.6	39.4
	other	421,558	32.1	49.2
TOTAL		1,312,758	100	

[1] Land cover estimated by supervised classification of Landsat Thematic Mapper scenes taken July 1991, (WDFW 1994b). Land ownership estimated from DNR's digital public land map (DNR 1995d).

[2]The area within the cover-type within the ownership class, divided by the total area described.

[3]The area within the cover-type within the ownership class, divided by the total area within the cover-type.

[4]Late seral forests = old-growth and large-saw cover.

[5]Mid-seral forests = small-saw cover.

[6]Other land cover = pole, sapling, open-canopy/mixed conifer, open areas (clearcuts, high-elevation barrens, towns, etc.), water, cloud/shadow cover.

[7]DNR-managed lands proposed as the Olympic Experimental State Forest (OESF).

[8]Other lands include all private ownerships, tribal lands, DNR-managed lands outside the OESF.

Table 4.4.9: Estimates of the habitat capability for spotted owls of DNR-managed and all lands in the Olympic Experimental State Forest area, currently and projected 100 years into the future under the No Action, Zoned Forest, and Unzoned Forest alternatives

Areas estimated to provide capable habitat had at least 40 percent potential habitat at the scale of 2.7-mile radius circles. Cover types that were assumed to be current potential habitat were old growth, large, and small sawtimber (WDFW 1994b). Cover types that were assumed to be potential habitat in 100 years were areas that were reserved from harvest and areas of DNR-managed forest or the Olympic National Forest that were managed for integrated outputs of commodity and ecosystem products and were predicted to be older than 50 years.

All lands in the OESF area

	Acres	Percent[1]	Percent Change from Current[2]	Percent Change from Projected No Action Alt.[3]
Currently Capable as Habitat	338,900	32		
Predicted to be Capable Habitat in 100 years under the No Action alternative	359,600	34	6	
Predicted to be Capable Habitat in 100 years under the Unzoned Forest alternative	511,300	48	51	46
Predicted to be Capable Habitat in 100 years under the Zoned Forest alternative	429,600	40	27	19
Total Land Area	1,066,300			

[1] Percent of total land area that is capable as habitat.

[2] Predicted area of capable habitat under each alternative divided by current area of capable habitat minus 1, expressed as a percent.

[3] Predicted area of capable habitat under each action alternative divided by predicted area of capable habitat under the No Action alternative minus 1, expressed as a percent.

DNR-managed Lands in the OESF area

	Acres	Percent[1]	Percent Change from Current[2]	Percent Change from Projected No Action Alt.[3]
Currently Capable as Habitat	48,900	18		
Predicted to be Capable Habitat in 100 years under the No Action alternative	36,800	14	-25	
Predicted to be Capable Habitat in 100 years under the Unzoned Forest alternative	153,400	57	214	317
Predicted to be Capable Habitat in 100 years under the Zoned Forest alternative	97,200	36	99	164
Total Land Area	270,000			

[1] Percent of total land area that is capable as habitat.

[2] Predicted area of capable habitat under each alternative divided by current area of capable habitat minus 1, expressed as a percent.

[3] Predicted area of capable habitat under each action alternative divided by predicted area of capable habitat under the No Action alternative minus 1, expressed as a percent.

Table 4.4.10: Model estimates of the current capability of hexagonal sites on DNR-managed and all lands on the Olympic Peninsula to provide habitat suitable to support pairs of spotted owls

	All Sites	Suitable Sites			
	Number	Number	Median Score	Max. Score	Min. Score
All Sites	1,239	435	4.40	8.99	0.25
Sites with some DNR-managed land	234	61	1.10	7.64	0.00
Sites with >90 percent DNR-managed land	27	9	1057	4.50	0.63

Table 4.4.11: Model estimates of the capability in 100 years of hexagonal sites on DNR-managed and all lands on the Olympic Peninsula to provide habitat suitable to support pairs of spotted owls under the No Action, Zoned and Unzoned Forest HCP alternatives for the OESF

ALTERNATIVE 1	All Sites	Suitable Sites			
	Number	Number	Median Score	Max. Score	Min. Score
All Sites	1,239	470	4.77	8.99	0.45
Sites with some DNR-managed land	234	67	1.12	7.64	0.00
Sites with >90 percent DNR-managed land	27	8	1.57	4.50	0.63
ALTERNATIVE 2	**All Sites**	**Suitable Sites**			
	Number	**Number**	**Median Score**	**Max. Score**	**Min. Score**
All Sites	1,239	505	4.67	8.99	0.15
Sites with some DNR-managed land	234	99	1.98	7.69	0.04
Sites with >90 percent DNR-managed land	27	24	4.13	5.27	2.39
ALTERNATIVE 3	**All Sites**	**Suitable Sites**			
	Number	**Number**	**Median Score**	**Max. Score**	**Min. Score**
All Sites	1,239	499	4.65	8.99	0.64
Sites with some DNR-managed land	234	92	1.82	7.69	0.03
Sites with >90 percent DNR-managed land	27	21	3.95	4.73	1.38

Table 4.4.12: An estimate of the proportion and ownership[1] of potential spotted owl habitat[2] within 2.7 miles of the 69 owl sites within 2.7 miles of DNR-managed lands in the Olympic Experimental State Forest, and the potential for DNR activities under the Zoned Forest alternative to result in incidental take at these sites

Site Characteristics	Site Status (number of sites)		*Zoned Forest Impacts*
>40 percent habitat on federal lands	pair 2 birds single unknown[3]	12 2 4 0	no potential for incidental take of these sites
≥40 percent habitat, federal minus DNR habitat <40 percent, inside owl zones or high priority circles or general management considerations will avoid take	pair 2 birds single unknown[4]	6 0 1 0	no potential for incidental take in first 40-60 years
≥40 percent habitat, federal habitat-DNR habitat <40 percent, Zoned Forest alternative or other considerations do not avoid take	pair 2 birds single unknown[4]	4 0 0 0	some potential for incidental take at these sites
<40 percent habitat, inside owl zones or high priority circles	pair 2 birds single unknown[4]	19 0 4 4	no potential for incidental take in first 40-60 years, no take of unknown sites (see footnote 4)
<40 percent habitat, Zoned Forest alternative or other considerations do not avoid take	pair 2 birds single unknown[4]	4 0 4 5	some potential for incidental take at these sites, not take of unknown sites (see footnote 4)

[1]Estimated from digital maps of public land ownership (DNR 1995d).

[2]Estimates of spotted owl habitat, including old forest, and younger forest habitat (Hanson et al. 1993), were based on a supervised classification of Landsat Thematic Mapper (TM) scenes taken July 1991 (WDFW 1994b). Habitat proportions reflect all old growth and large-saw cover, and half of the small-saw cover as estimated by TM.

[3]Based on the WDFW Interagency spotted owl database, July 1995: pair - observations of two owls behaving as a pair; 2 birds - observations of two birds not behaving as a pair; single - repeated observations of a single owl suggesting territorial status; unknown - isolated observations that do not suggest territorial status.

[4]Take can occur at sites occupied by pairs, two birds pair status unknown, and territorial singles only (60 Fed. Reg. 9484 (1995)).

Table 4.4.13: An estimate of the proportion and ownership[1] of potential spotted owl habitat[2] within 2.7 miles of the 69 owl sites within 2.7 miles of DNR-managed lands in the Olympic Experimental State Forest, and the potential for DNR activities proposed under the Unzoned Forest alternative to result in incidental take at these sites

Site Characteristics	Site Status[3] (number of sites)		Unzoned Forest Impacts
>40 percent habitat on federal lands	pair 2 birds single unknown [4]	12 2 4 0	no potential for incidental take of these sites
≥40 percent habitat, federal habitat- DNR habitat <40 percent	pair 2 birds single unknown [4]	10 0 1 0	no potential for incidental take at these sites, no take of unknown sites (see footnote 4)
<40 percent habitat	pair 2 birds single unknown [4]	23 0 8 9	some potential for incidental take at these sites, no take of unknown sites (see footnote 4)

[1] Estimated from digital maps of public land ownership (DNR 1995d)

[2] Estimates of spotted owl habitat, including old forest and younger forest habitats (Hanson et al. 1993), were based on a supervised classification of Landsat Thematic Mapper (TM) scenes taken July 1991 (WDFW 1994b). Habitat proportions reflect all old growth and large-saw cover, and half of the small-saw cover as estimated by TM.

[3] Based on the WDFW Interagency spotted owl database, July 1995: pair - observations of two owls behaving as a pair; 2 birds - observations of two birds not behaving as a pair; single - repeated observations of a single owl suggesting territorial status; unknown - isolated observations that do not suggest territorial status.

[4] Take can occur at sites occupied by pairs, two birds pair status unknown, and territorial singles only (60 Fed. Reg. 9484 (1995)).

Table 4.4.14: Projections of the proportion of the Olympic Experimental State Forest covered by young and old forest owl habitat based on an exploratory analysis[1] of the outcomes of potential management scenarios under the Unzoned Forest alternative

Habitat Type[2]	percent of OESF in Cover-Type at Different Times (years) in the Future			
	0	30	50	100
Young Forest	14	43	58	26
Old Forest	19	18	18	39
All	33	60	75	65

[1]Martin 1995

[2]Habitat definitions based on Hanson et al. 1993.

Figure 4.4.7a-d: Estimates of habitat capability for spotted owls of the Olympic Experimental State Forest areas currently, and under the No Action, Zoned Forest, and Unzoned Forest HCP alternatives

Figures depict major federal and tribal ownership by fine-grained shading and areas that were estimated to provide at least 40 percent potential habitat at the scale of pair ranges (2.7 miles) by coarse hatching. Figure 4.4.7a is based on estimates of current habitat capability derived from analysis of Landsat Thematic Mapper Imagery gathered in July 1991 (WDFW 1994b). Figures 4.4.7b, c, and d are based on projections of No Action, Zoned Forest, and Unzoned Forest alternatives, respectively, 100 years into the future.

Figure a

Figure b

Figure c

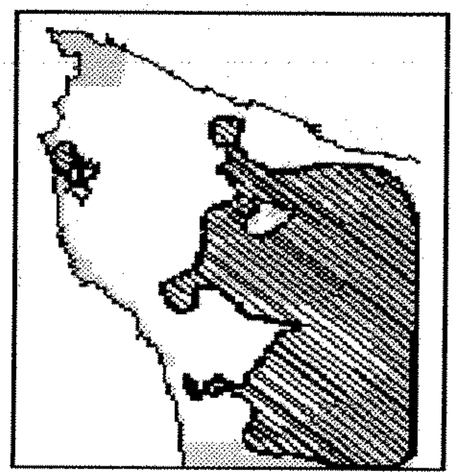


Figure d

Figure 4.4.8: Hexagonal habitat map constructed to represent current conditions. ■ = suitable sites; ▒ = unsuitable sites; ■ = reflecting barriers to movement.

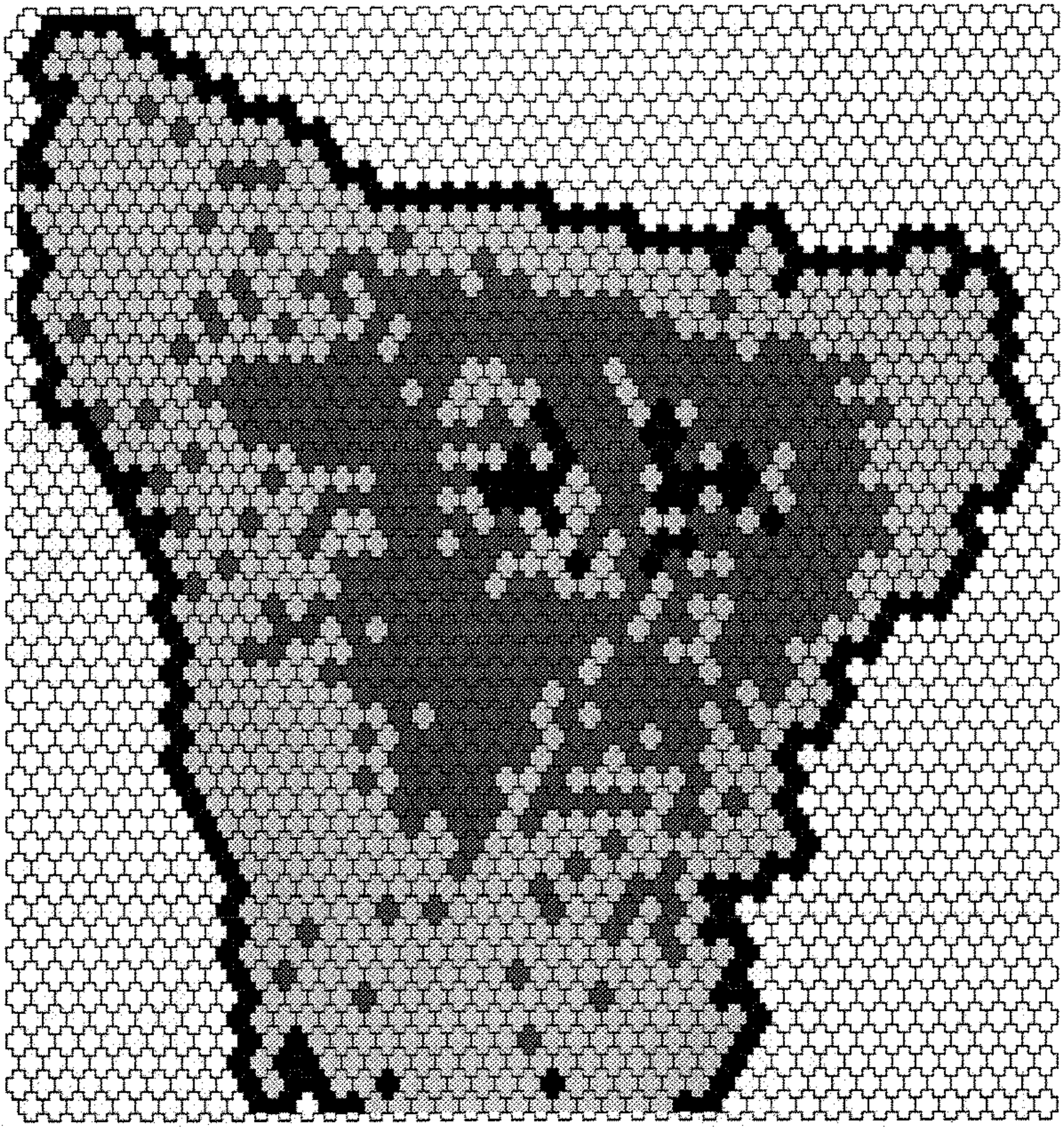


Figure 4.4.9: Histogram of numeric distribution of site scores at year 100 derived from hexagonal habitat map in Figure 4.4.8 (year 2094). ■ = suitable sites; ▒ = unsuitable sites. There were 1239 sites and 470 of these were suitable.

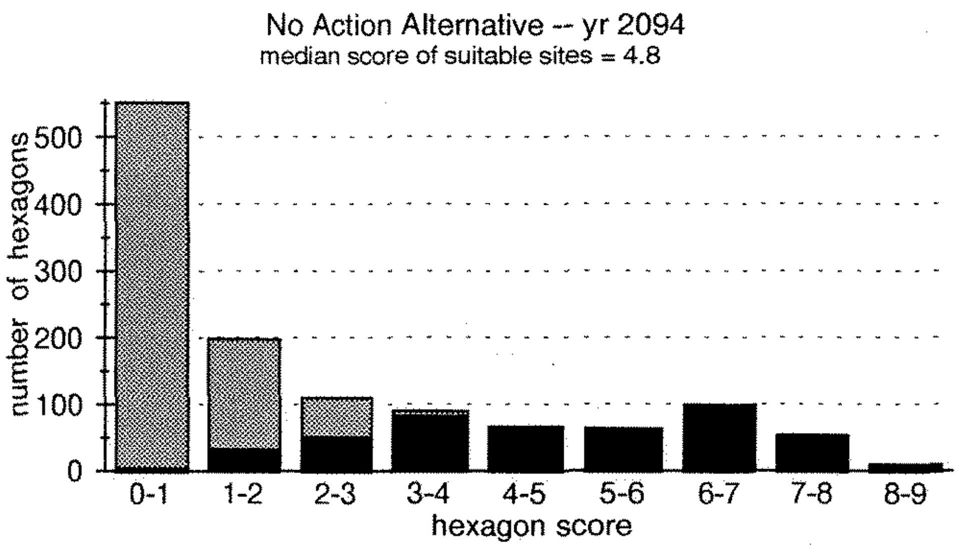


Figure 4.4.10: The numbers of suitable sites projected to result from each of the HCP alternatives for the OESF. Numbers of suitable sites were derived from hexagonal habitat maps in Figures 4.4.11, 4.4.12, and 4.4.13. "Static" is the 1994 hexagonal habitat map (Figure 4.4.8) held constant, and is presented as a base line for comparison.

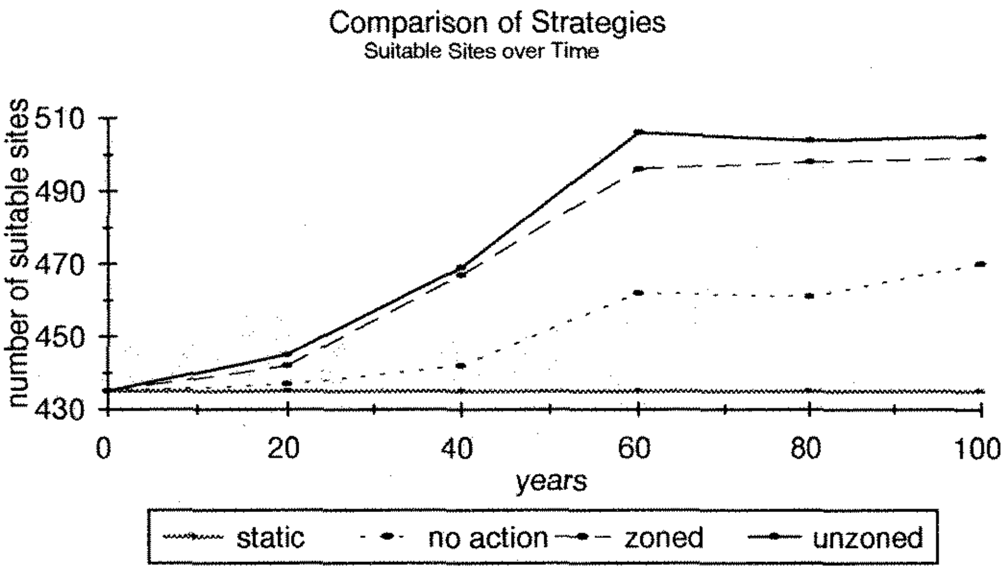


Figure 4.4.11: Time series of hexagonal habitat maps constructed for the No Action alternative for the OESF. ■ = suitable sites; ▒ = unsuitable sites; ■ = movement barriers.

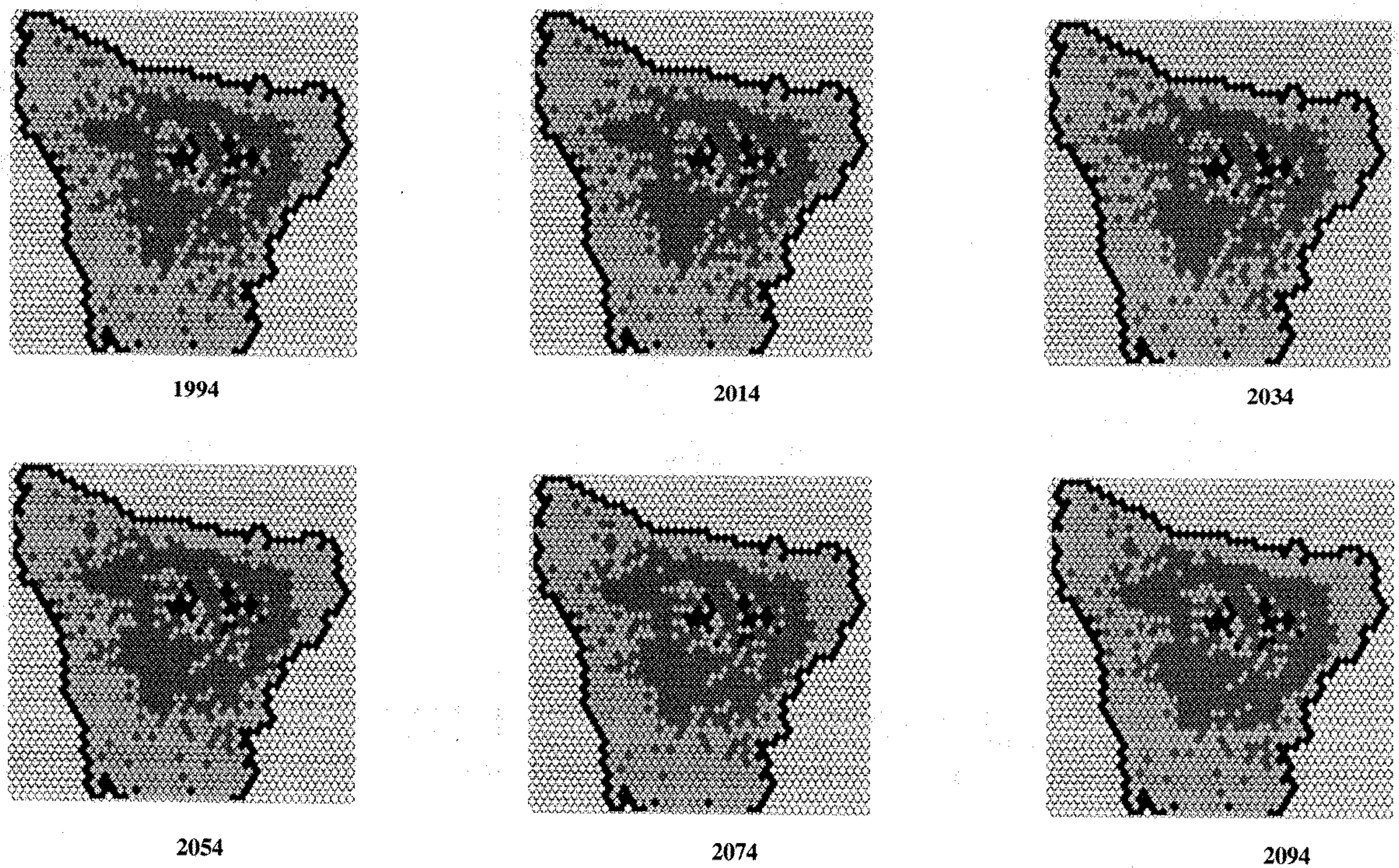


Figure 4.4.12: Time series of hexagonal habitat maps constructed for the Zoned Forest alternative for the OESF. ■ = suitable sites; ▒ = unsuitable sites; ■ = movement barriers.

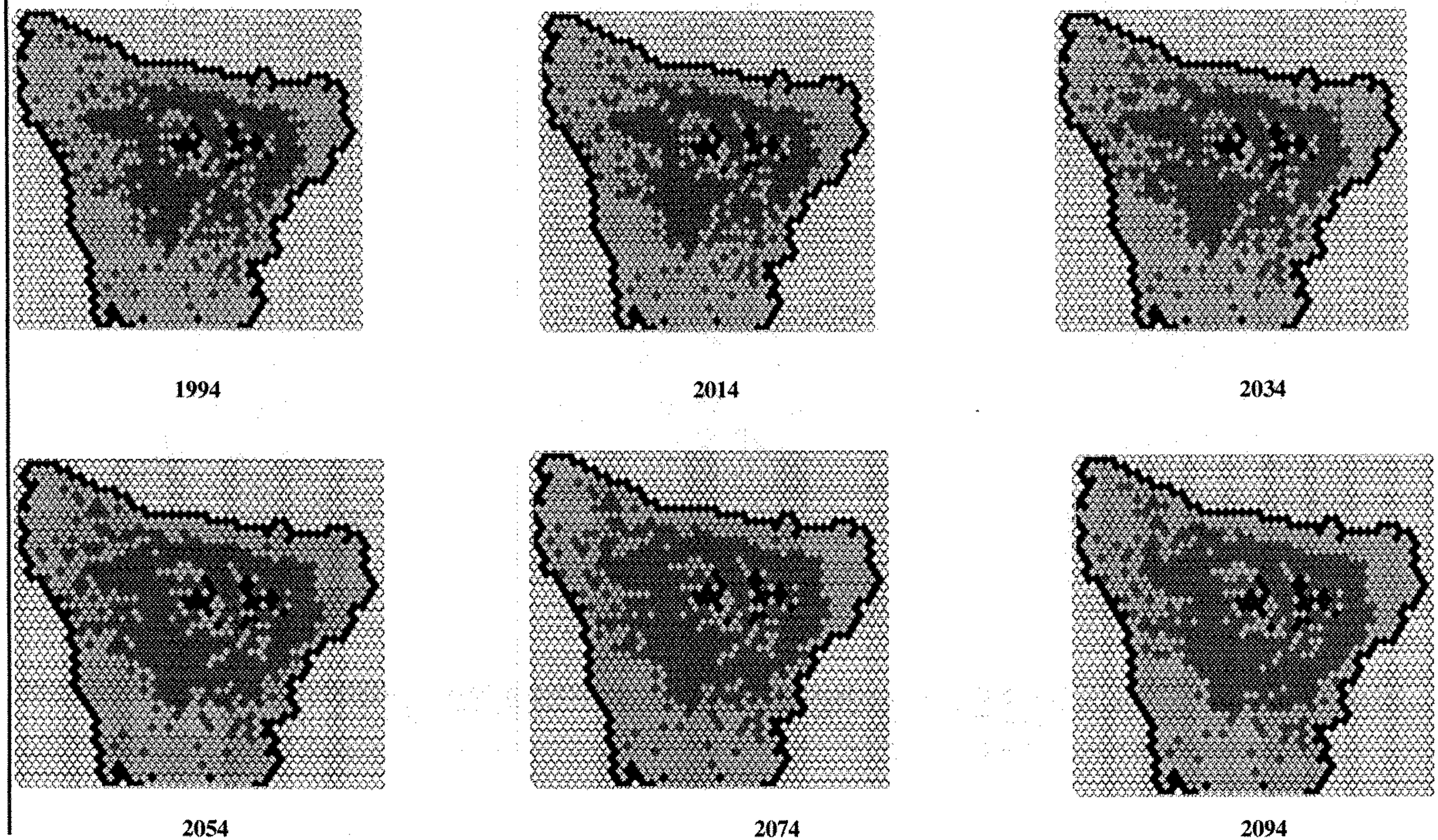


Figure 4.4.13: Time series of hexagonal habitat maps constructed for the Unzoned Forest alternative for the OESF. ■ = suitable sites; ▒ = unsuitable sites; ■ = movement barriers.

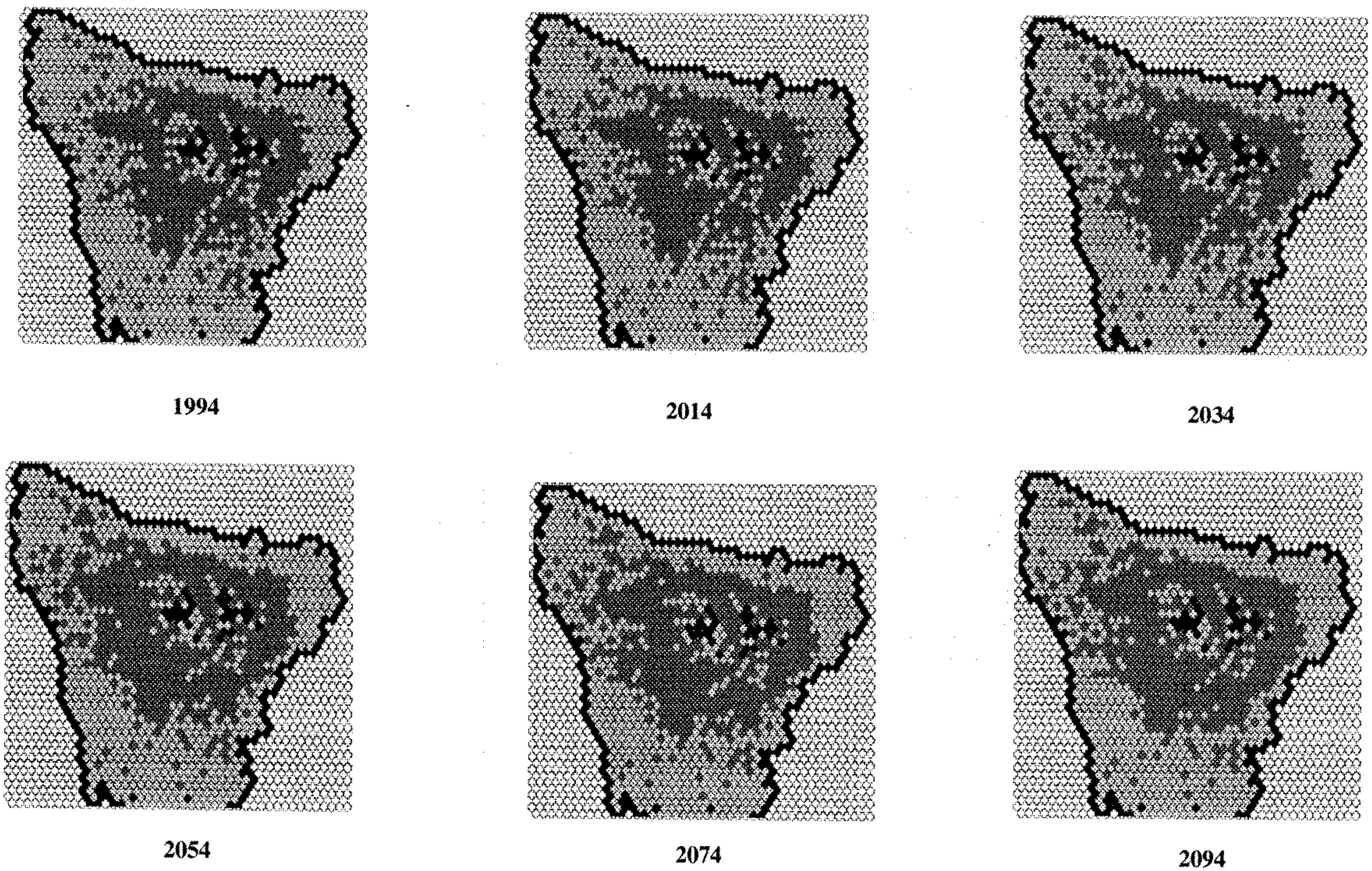
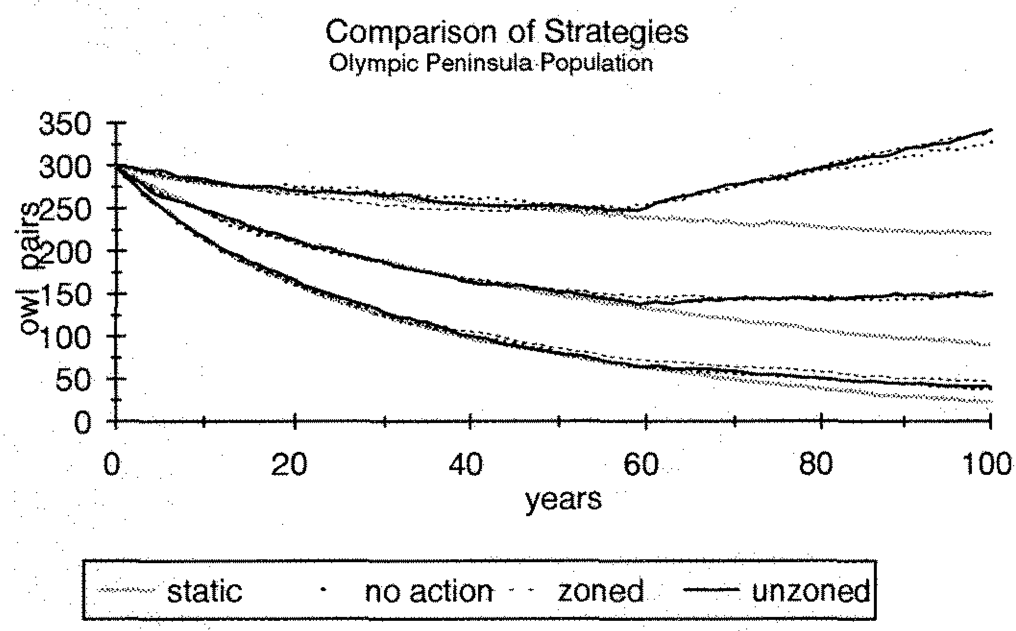


Figure 4.4.14: Projected trajectories of the Olympic Peninsula spotted owl population.

There are three sets of four trajectories representing combinations of each of the three HCP alternatives for the OESF and the static landscape with three sets of assumptions about demographic parameters. For the top set juvenile survivorship equaled 0.53, for the middle set juvenile survivorship equaled 0.47, and for the bottom set it equaled 0.41. Hexagonal habitat maps were changed at years 20, 40, 60, and 80.



4.4.4 Analysis of Consequences to Marbled Murrelet, Other Wildlife and Plant Species in the OESF

Marbled Murrelet Conservation

The conservation strategies for the marbled murrelet in the OESF are the same as the strategies for all other west-side planning units. The analysis of potential environmental consequences related to marbled murrelet conservation strategy is covered for all six west-side planning units, including the OESF, in Section 4.2.2. When the long-term conservation plan is developed, it may or may not propose different strategies for the OESF than for the other five west-side planning units.

Other Wildlife Species

The combined riparian, spotted owl, and marbled murrelet conservation strategies and mitigation measures in the OESF may affect other wildlife and fish species differently in the OESF than in the other planning units. Assessments of potential impacts under the OESF No Action alternative and the two action alternatives for the OESF are included in Sections 4.5.1 and 4.5.2.

Plant Species

The combined effects of the riparian, spotted owl, and marbled murrelet conservation strategies on sensitive plant species in the Olympic Experimental State Forest for the OESF No Action alternative and the two HCP action alternatives for the OESF are also described in Section 4.5.3.

4.5 Other Species and Habitats

4.5.1 Section 10A Permit Species

Matrix 4.5.1a: Management strategies for HCP (excluding OESF)

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Other Federally Listed Species			
West-side units, east-side units, and OESF	Other federally listed species protected through meeting requirements of federal and state laws and the development of bald eagle site management plans.	Other federally listed species protected through meeting requirements of federal and state laws and the development of bald eagle site management plans, plus spotted owl, marbled murrelet, and riparian conservation strategies and additional mitigation for: (1) peregrine falcon: site-specific protection with restricted access to lands within .5 mile of active aerie and protection of location information; (2) gray wolf: establish wolf habitat management area and develop plans to limit human disturbance for land within 8 miles of documented sightings; and, (3) grizzly bear: establish grizzly bear habitat management area and develop plans to limit human disturbance for land within 10 miles of documented sightings.	Same as Alternative B.

Matrix 4.5.1b: Management strategies for alternatives related to the OESF planning unit

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Other Federally Listed Species			
Other Federally Listed Species	Other federally listed species protected through meeting requirements of federal and state laws, development of bald eagle site management plans	Landscape-level management, built around riparian, spotted owl, and marbled murrelet conservation, provides primary protection for other federally listed species. Additional mitigation for: (1) bald eagle: continue nest-site-management process; and, (2) peregrine falcon: site-specific protection; restricted access within 0.5 mile of aerie; protect location information.	Same as Alternative 2.

Oregon Silverspot Butterfly (*Speyeria zerene hippolyta*)

The Oregon silverspot butterfly is listed by the federal government as threatened and by the state as endangered. It inhabits salt spray meadows, stabilized dunes, and open fields that support its larval host plant, the western blue violet (*Viola adunca*). Forested edges adjacent to meadows used by the Oregon silverspot are also considered important habitat (WDW 1993d). Such sheltered areas enable the Oregon silverspot to bask, perch, seek nectar, court, and mate despite strong ocean winds that characterize coastal areas (WDW 1993d). Critical habitat has not been designated under the Endangered Species Act (WDW 1993d). A 1991 survey found no Oregon silverspot butterflies in Washington (WDW 1993d). Prior to 1994, a small parcel of land was managed by DNR near a past species sighting on the north end of Long Beach Peninsula. In 1994 this parcel was sold to State Parks.

None of the alternatives offer specific strategies for directly managing habitat of the Oregon silverspot butterfly, such as provisions for maintenance of meadows where the western blue violet might be found. However, it is expected that none of the alternatives would have major effects on the Oregon silverspot butterfly due to its limited distribution in Washington State, its rare potential for occurrence on DNR-managed land, and its minimal use of forests.

ALTERNATIVE A

Current policies may provide adequate protection for the Oregon silverspot butterfly and its habitat (DNR 1992b; see Chapter 2). If salt spray meadows potentially occupied by this species are classified as wetlands, full implementation of Forest Resource Plan (FRP) Policy No. 21, entailing no net loss of wetlands, would provide substantial habitat protection for this species. Buffers designed to maintain the hydrologic function of the wetland may further contribute to Oregon silverspot conservation by providing forested edge habitat and maintaining wetland quality. When fully implemented,[1] this would prevent direct habitat loss and provide future habitat should the species expand its current range.

Forest Resource Plan Policy No. 23 specifically addresses the threatened and endangered status of the species, and states that DNR will comply with federal and state regulations. Washington Forest Practices Rules require completion of an environmental checklist in compliance with SEPA for harvesting timber, road construction, aerial or ground application of pesticides, or site preparation within 0.25 miles of a Washington Department of Fish and Wildlife (WDFW) documented individual occurrence of an Oregon silverspot butterfly (WAC 222-16-080e). This policy should prevent direct harm to the species, provided that WDFW keeps accurate and frequently updated records of

[1] The "no net loss of wetlands" policy is not fully implemented yet. Until such time, it is reasonable to assume that DNR will, at a minimum, adhere to the Washington Forest Practices Rules regarding wetlands. These rules entail the establishment of average wetland management zones (WMZ) of 50-100 feet around Type A Wetlands, bogs, or fens and 25-50 feet around Type B Wetlands greater than 0.5 acres where 75 trees per acre are left.

Oregon silverspot occurrences. Therefore, the overall risk and impact to the Oregon silverspot butterfly under Alternative A is minimal.

ALTERNATIVE B

Alternative B ultimately provides the same habitat protection for the Oregon silverspot butterfly as Alternative A, because it employs the same wetland strategy and complies with state and federal species-specific endangered and threatened species regulations. However, Alternative B would provide more consistent protection than Alternative A through the detailed guidance it provides for the implementation of the wetlands policy, including specific buffer widths and harvest restrictions. However, it is not likely that the forest management activities of either Alternative A or B will substantially impact the Oregon silverspot butterfly or alter its conservation, due to the limited distribution and rare potential occurrence of this species on DNR-managed lands.

ALTERNATIVE C

If Oregon silverspot butterfly habitats are classified as wetlands, this alternative would provide the most protection for the species, because it would distribute more potential habitat of greater quality across the planning area. Unlike Alternatives A and B, the wetland strategy of Alternative C would retain buffers around smaller bogs (0.1 acres) and wetlands (no minimum if the wetland connects other wetlands or typed water, functioning together like one larger wetland), prohibit harvest through the 50-foot zone bordering nonforested wetlands, and provide more stringent ground-disturbance constraints. The no-harvest zones within the buffers would provide the highest quality protection of potential Oregon silverspot butterfly forested edge habitat. DNR would also continue to comply with the species-specific requirements of the Washington Forest Practices Rules and the Wildlife Code of Washington. Thus, Alternative C provides greater certainty that future Oregon silverspot habitat distribution and quality would be maintained and relatively minimizes potential impact due to forest management activities, compared to Alternatives A and B.

OESF ALTERNATIVES

This species does not occur within the OESF Planning Unit.

Aleutian Canada Goose (*Branta canadensis leucopareia*)

Listed by the both federal government and state as threatened, members of this subspecies of the Canada goose might intermittently occupy sites within the plan area as they migrate between their Alaskan breeding and Oregon and California wintering grounds. Rodrick and Milner (1991) identified habitat used by the geese during migration in and near Willapa Bay and along the lower reaches of the Columbia River. Other potential resting and feeding sites include lakes, large ponds, wetlands, grasslands, meadows, and agricultural fields. Although there is no specific management guidance in any of the alternatives for the management of grasslands or meadows, conservation of the Aleutian Canada goose would be peripheral to DNR's forest management activities due to the rare occurrence of the geese on DNR-managed lands and their lack of association with forested habitats.

ALTERNATIVE A

Under this alternative, general habitat protection would be afforded to the Aleutian Canada goose by compliance with wildlife, wetland, and riparian management zone provisions of DNR's FRP Policies (Nos. 20, 21, and 23) and Washington Forest Practices Rules. Maintaining water quality and protecting lakes and ponds classified as Type 1, 2, 3, or 4 Waters (FRP Policy No. 20) would enhance resting areas, and protecting associated riparian vegetation would maintain foraging opportunities. FRP Policy No. 21, entailing no net loss of wetlands, would also benefit the Aleutian Canada goose by preventing loss of forage and resting areas. Wetland buffers would maintain forage opportunities due the restriction on types of timber harvest activities within them. FRP Policy No. 23, directing DNR to voluntarily participate in the recovery of threatened and endangered species and follow federal and state guidelines for such species, would allow DNR to take further conservation measures should areas managed by DNR become Aleutian Canada goose habitat in the future. Implementation of these policies under Alternative A would likely result in little overall impact to and adequate protection of the Aleutian Canada goose because they distribute resting and foraging areas throughout the planning area. However, the general policy direction offered by Alternative A concerning riparian and wetland management zones would result in inconsistent habitat quality throughout the plan area due to less stringent establishment of the proposed zones.

ALTERNATIVE B

This alternative would result in greater protection for Aleutian Canada goose than Alternative A, primarily due to its more explicit riparian conservation strategy. The greater protection would be the result of larger and less manipulated buffers on ponds and lakes (Type 1 through 4 Waters; see Chapter 2) , including inner riparian management zones (minimum 100 feet) and outer wind buffers where there is a moderate potential for windthrow. These buffers would effectively maintain or increase the amount and quality of resting and foraging areas available to the species. Overall, Alternative B would provide more protection of the Aleutian Canada goose than Alternative A by ensuring a potentially greater amount of higher quality habitat over the planning area through the implementation of specific riparian habitat conservation strategies.

ALTERNATIVE C

Alternative C would provide the most protection for this species and least impact to its habitat of all the alternatives, due to its enhanced wetlands and riparian conservation strategies that further distribute more protected habitat over a broad geographic area. Through its elimination of timber harvest through the 50-foot zone bordering nonforested wetlands, application of buffers to bogs and wetlands of smaller sizes, limitation on harvest of trees within the remainder of the buffer surrounding wetlands, incorporation of an increased buffer for high-risk slope conditions, and more stringent ground-disturbance constraints, the wetland strategy of Alternative C should provide substantial protection of Aleutian Canada goose foraging and resting areas. Overall, the riparian conservation strategy of this alternative, with its increased buffers and restrictions of harvest activities within riparian management zones, would benefit the Aleutian Canada goose by maintaining the quality of aquatic systems, including lakes and ponds it might use for foraging and resting sites along its migratory route. This alternative offers substantially more protection of the species than Alternative A by distributing a greater amount of higher quality habitat throughout the planning area. The enhanced conservation strategies provide more confidence that the species' habitat needs will be met than Alternative B.

OESF ALTERNATIVES

Alternative 1. Under the No Action alternative for the OESF, management and resulting effects would be the same as those described in Alternative A, above.

Alternative 2. The unzoned OESF alternative would result in an increased level of protection compared to the No Action alternative for the Aleutian Canada goose due to two factors: (1) enhanced riparian ecosystem quality derived from 150-foot average inner-core buffers on Type 1 through 3 Waters and 50-foot inner buffers on Type 4 and 5 Waters; and (2) more protection of forage and resting opportunities as a direct result of prohibited harvest within 50 feet of nonforested wetlands. These factors would minimize the impact of forest management activities on Aleutian Canada goose habitat.

Alternative 3. Same as Alternative 2.

Bald Eagle (*Haliaeetus leucocephalus*)

Of the seven states involved in the Pacific Bald Eagle Recovery Plan, Washington State supports the largest breeding and wintering populations of the bald eagle. This species is listed by both the federal government and state as threatened. DNR manages potential bald eagle habitat throughout the plan area, including forested land within one mile of major water bodies such as streams, estuaries, lakes, sloughs, reservoirs, and coastal beaches (Brown 1985; USDI 1986). Most nesting occurs within the San Juan Islands or along the Olympic coastline, but nesting territories are also found along Hood Canal, on the Kitsap Peninsula, within Island County, along the lower reaches of the Columbia River, and in eastern Washington (USDI 1986). Critical wintering areas with communal roost sites occur along the north fork of the Nooksack River, where DNR manages a portion of at least six sites.

Habitat suitability for bald eagles involves provision of accessible prey and trees for nesting and roosting (Stalmaster 1987). Food availability, such as aggregations of waterfowl or salmon runs, is a primary factor attracting bald eagles to wintering areas and influences nest and territory distribution (Stalmaster 1987; Keister et al. 1987). Nests are most commonly constructed in Douglas-fir or Sitka spruce trees, with average heights of 116 feet and 50 inches dbh (Anthony et al. 1982). Roost trees are usually the most dominant trees of the site and provide unobstructed views of the surrounding landscape (Anthony et al. 1982), although they are often in ravines or draws that offer shelter from inclement weather (Hansen 1978; Keister 1981).

ALTERNATIVE A

Under this alternative, conservation of bald eagles would occur through compliance with FRP Policies (Nos. 20, 21, 22, and 23) that direct DNR to protect riparian areas, achieve no net loss of wetland acreage or function, protect endangered and threatened species, and maintain upland wildlife habitat. These general policy statements provide initial guidance for maintaining the integrity of habitats near water where bald eagles find major prey items (i.e., waterfowl and salmonids) and sites for nesting and roosting (i.e., within riparian management zones and upland habitat). Also, DNR's compliance with the Washington Forest Practices Rules and the Wildlife Code of Washington would protect bald eagle nests (within 0.5 mile, as documented by WDFW, January 1-August 15; 0.25 mile at other times in the year) and communal roost sites (0.25 mile) from timber harvesting, road construction, aerial application of pesticides or site preparation activities (WAC 222-16-080a; WAC 232-12-292). Negative impacts to eagle habitat would still be expected because existing eagles would continue to be the focus of Alternative A. Under Alternative A, there is minimal emphasis on the development of future habitat due to the lack of commitment to specific riparian zone buffers and lack of specific harvest restrictions in riparian buffers for nesting, roosting, and prey habitat, and lack of specific retention of very large trees for nesting and roosting sites.

ALTERNATIVE B

In addition to the established state and agency policies, Alternative B would provide greater conservation for bald eagles and less impact to eagle habitat than Alternative A through its riparian conservation strategy and by requiring retention of very large old trees. Riparian buffers averaging 150 feet, including a 25-foot no-harvest zone next to the stream, would provide essential nest trees and roost sites. The focus of the riparian buffer on protection of salmonid habitat should directly benefit bald eagles, if the conservation strategy results in more abundant salmon, because salmon are primary prey of the species. Likewise, buffers around ponds and lakes that increase the abundance of waterfowl would benefit bald eagles by providing prey. The riparian management zones in the west-side planning units would be managed to provide large woody debris for salmonids, which should benefit bald eagles by maintaining large nest and/or roost trees (116 feet tall and 50-inch dbh) (Anthony et al. 1982) along major watercourses. Nest and roost trees are also addressed by the very large old tree retention policy (two trees per harvested acre, with at least 50 percent in the largest living diameter trees available on the unit before harvest, see Chapter 2). Overall, Alternative B would offer more substantial, widely distributed, and potentially effective protection of the bald eagle through time than Alternative A.

ALTERNATIVE C

In addition to established state and agency policies, Alternative C would provide the greatest conservation of bald eagles and least impact to eagle habitat through its more comprehensive riparian conservation and wetland strategies. Not only would the increased buffer widths and harvest restrictions within wetland and riparian buffers result in more habitat available within the planning area, but they would also maintain or improve the quality of the riparian ecosystem. This increased attention to riparian habitat would benefit bald eagles because salmon and waterfowl are important prey sources for the species. Combined with the old tree retention policy and compliance with the Washington Forest Practice Rules and the Wildlife Code of Washington, the net result of Alternative C would be to increase the effectiveness and/or certainty of protection of bald eagles over Alternatives A and B.

OESF Alternatives

Alternative 1. Under the No Action alternative for the OESF, management and resulting effects would be the same as those described in Alternative A, above.

Alternative 2. The unzoned OESF alternative would result in an increased level of protection for bald eagles and relatively less impact to eagle habitat compared to the No Action alternative due to four factors. First, the development of mature and old-growth forests within riparian zones, especially along Type 1 and 2 Waters, would provide nest and communal roost sites. Second, retention of very large old trees (see Chapter 2) should result in additional nest and communal roost sites dispersed within upland habitats. Third, the principal prey of the bald eagle is fish, and riparian protection would enhance fish populations. The expected result would be a higher bald eagle density on inland habitat, thereby broadening the geographical and ecological distribution of the species on the peninsula. The broadening of the species distribution provides a final benefit: decreased susceptibility to large-scale environmental change, such as natural catastrophic disturbance.

Alternative 3. Same as Alternative 2.

Peregrine Falcon (*Falco peregrinus*)

The peregrine falcon is listed by both the state and federal government as endangered. Although three subspecies occur in Washington State, only *F. p. anatum*, is believed to nest in Washington (along the Pacific coast, the Columbia River Gorge, and in the San Juan Islands) (Allen 1991). Potential peregrine falcon habitat managed by DNR includes land near estuaries and other water bodies where large concentrations of shorebirds, songbirds, and waterfowl accumulate. Nearby cliffs, high escarpments, bridges, and river cutbanks might also be used for nesting (Pacific Coast American Peregrine Falcon Recovery Team 1982; Craig 1986). Conservation of peregrine falcons would be peripheral to DNR's forest management activities because the falcons are rarely associated directly with forests.

Alternative A

Several current policies direct DNR to provide protection for the peregrine falcon, its habitat, and its prey habitat. Under Alternative A, the establishment of riparian management zones along streams and major water bodies (FRP Policy No. 20) and achieving "no net loss of wetlands" (FRP Policy No. 21) would maintain or increase the amount of available prey by addressing prey habitat quality. Compliance with the Washington Forest Practices Rules (WAC 222-16-80f), which mandates a SEPA environmental checklist for timber harvesting, road construction, aerial application of pesticides, or site preparation within 0.5 mile of a known active nest site March 1-July 30; or harvesting, road construction, or aerial application of pesticide within 0.25 mile of the nest at other times, will provide direct protection for known individuals and nests (FRP Policy No. 23). Known sites are those documented by WDFW. The implementation of these policies would provide adequate protection of the species, but would offer little certainty for the protection of future or undetected nest sites.

ALTERNATIVE B

Although DNR's forest management activities are not anticipated to have major impacts on peregrine falcons or their habitat under any of the alternatives, Alternative B would improve habitat conditions over those provided in Alternative A by specifically addressing cliff habitat (potential nest sites) and specifying a detailed west-side riparian conservation strategy (prey habitat). First, protection of cliff habitat would benefit undiscovered and future nest sites. Public access to DNR-managed lands within 0.5 miles of falcon aeries would be restricted where practicable. Secondly, buffers along streams and water bodies and the specific and consistent strategies to achieve the FRP in the riparian conservation strategy of this alternative would prevent potential loss of prey habitat and improve habitat quality compared to Alternative A. These provisions would amplify the benefits of the established state and federal agency peregrine falcon policies and contribute to the conservation of the species.

ALTERNATIVE C

Alternative C provides greater enhancement of peregrine falcon habitat than the other alternatives through its more comprehensive riparian and wetland conservation strategies. The primary benefit of these strategies is improved confidence that the goals of maintaining hydrologic function of wetlands and quality salmonid habitat will be met. These strategies, such as restriction of harvest activity near and within wetlands, lakes, and ponds classified as Type 1, 2, or 3 Waters, are key to providing abundant habitat for prey of the peregrine falcon. Also, restriction of public access to aeries where practicable and protection of cliff habitat would be implemented, and thus protect nesting falcons. These provisions would amplify the benefits of the established state and federal agency peregrine falcon policies and improve confidence that the habitat needs of the species would be met throughout the plan area.

OESF ALTERNATIVES

Alternative 1. Under the No Action alternative for the OESF, management and resulting effects would be the same as those described in Alternative A.

Alternative 2. The unzoned OESF alternative would provide protection of peregrine falcons through the enhanced riparian conservation strategy that would generally improve wildlife habitat compared to the No Action alternative, and the site-specific conservation of cliff habitat as described in the multispecies strategy on uncommon habitats (see HCP). In addition, DNR would restrict public access within 0.5 mile of any known peregrine falcon aeries. The location of the aeries would be kept confidential between DNR, USFWS, and WDFW.

Alternative 3. Same as Alternative 2.

Columbian White-tailed Deer (*Odocoileus virginianus leucurus*)

Inhabiting riparian forests, meadows, abandoned pastures, and other grasslands less than approximately 10 feet above sea level, the Columbian white-tailed deer is both federally and state-listed as endangered. The deer formerly occupied open forested lands, tidal spruce swamps, and wetlands (Columbian White-Tailed Deer Recovery Team 1983). Currently, they only occur along an 18-mile stretch of the Columbia River near Cathlamet, Washington, on several islands, and near Roseburg, Oregon (Columbian White-Tailed Deer Recovery Team 1983). It is thought that competition with the black-tailed deer for bottomland habitat has prevented Columbian white-tailed deer from expanding their range (Rodrick and Milner 1991).

DNR-managed lands within the deer's range are in the process of being transferred to the U.S. Fish and Wildlife Service as part of the Julia Butler Hansen Columbian White-Tailed Deer National Wildlife Refuge. Parcels on Puget Island are leased to private landowners for dryland agriculture, grazing, and home sites but are not covered by this HCP. Therefore, forest management activities within the plan area are not expected to affect the Columbian white-tailed deer, unless they expand from their current range during the planning period.

ALTERNATIVE A

Conservation of the Columbian white-tailed deer and its habitat would be directed by FRP Policies (Nos. 20, 21, 22, and 23) that mandate general protection for riparian areas through the establishment of riparian management zones, no net loss of wetland acreage or function including wetland buffers, protection of endangered and threatened species, and upland wildlife habitat maintenance. Implementation of these policies under this alternative would minimize impacts to future Columbian white-tailed deer habitat by resulting in maintenance of riparian cover and forage for the deer.

ALTERNATIVE B

This alternative improves upon Alternative A by providing greater protection for potential Columbian white-tailed deer habitat through its more specific riparian conservation strategy. The 25-foot no-harvest zone and average 150-foot riparian buffers along major rivers and water bodies would provide greater confidence that forage and cover resources would be available to Columbian white-tailed deer than the general policy statements of Alternative A. The net result of Alternative B would be less impact to and greater conservation of habitat that could be utilized by Columbian white-tailed deer in the future.

ALTERNATIVE C

This alternative would provide the most confidence that future habitat for this species would be provided within the planning area. Under the enhanced riparian and wetland conservation strategies of Alternative C, DNR would maintain deer cover and browse by applying buffers to smaller bogs and wetlands, prohibiting harvest through the 50-foot zone bordering nonforested wetlands, limiting harvests within forested wetlands and wetland buffers (forage and cover), and maintaining vegetation in riparian management zones (see Chapter 2). Alternative C would provide substantial confidence that future Columbian white-tailed deer habitat needs will be met, compared to Alternative A.

OESF ALTERNATIVES

This species does not occur within the OESF Planning Unit.

Gray Wolf (*Canis lupus*)

The gray wolf is a habitat generalist that may potentially be found throughout the Cascade Range from the northern Washington border south to the Columbia River, and the northeastern third of the state, from the Cascade Range east through the Okanogan Highlands to the Idaho border.[2] This species is listed by both the federal government and state as endangered. Virtually all naturally vegetated lands are considered potential habitat for this species, with the most suitable habitats being those that support dense ungulate populations, such as deer, elk, moose, and mountain goats, in remote areas (Laufer and Jenkins 1989). Wolves typically den under logs or rock outcrops (Thomas 1979). There have been three gray wolf observations within the plan area (one in 1989 and two in 1992; WDFW Natural Heritage GIS data from 1989-93).

A crucial aspect of gray wolf habitat management is minimizing the potential for negative human interactions. Killing of wolves occurs despite legal protection and is positively correlated to road density (Mech 1980; Fuller 1989). Also, gray wolves generally use areas that have less than 0.93 miles of road per square mile (Paquet and Hackman 1995, and references therein). Therefore, road management planning in conjunction with forest management activities can contribute to the recovery of gray wolves.

ALTERNATIVE A

Conservation of the gray wolf would be guided by FRP Policies (Nos. 20, 21, 22, and 23) that mandate general protection for riparian areas, no net loss of wetland acreage or function, protection of endangered and threatened species, and upland wildlife habitat maintenance. A SEPA environmental checklist would be undertaken for harvesting, road construction, or site preparation within one mile of a WDFW-documented den site between March 15 and July 30, or within 0.25 miles at other times (WAC 222-16-80b). No specific consideration is given to wolves or public access in DNR's road strategy in this alternative. Without such consideration, conservation of gray wolves would be minimal under this alternative.

ALTERNATIVE B

The gray wolf might benefit from the improved wildlife and ecosystem conditions afforded by the riparian and spotted owl conservation strategies of Alternative B. Increased shelter (maintenance of debris and mature forest conditions) and provision of prey (along riparian management zones and within harvest units) are benefits of this alternative. In addition, protection of talus slopes, caves, and cliffs might provide important denning and/or shelter opportunities for gray wolves. The spatial arrangement of spotted owl habitat in proximity to federal forests likely would provide wolves with travel opportunities. DNR will continue to participate in cooperative road closures with WDFW and the U.S. Forest Service to restrict vehicular activity to maintain or increase big game security. Additionally, to the extent practicable in appropriate areas, DNR will

[2] The Olympic Peninsula is no longer considered part of the gray wolf's range. The last wolf was probably shot before 1930 (Scheffer 1949), with most of the animals succumbing to poisoning, trapping, and shooting by settlers before 1920.

schedule management activities, including road construction and use, to occur at times of the year when wolves are least likely to be present.

Although no other proactive consideration is given to wolves or public access in DNR's road strategy in this alternative, there would be a mechanism to protect wolves if they were observed on DNR-managed lands. Site-specific plans would be developed in consultation with WDFW or USFWS to limit human disturbance within eight miles of a Class 1 gray wolf observation (see HCP). Disturbance would be limited in the area until five consecutive years pass without further observations. However, there is no process outlined for detecting such observations. Without at least minimal survey effort, it is unlikely that a Class 1 observation would occur, even if a wolf were present. Nonetheless, Alternative B increases the level of protection of the gray wolf and its habitat through its more comprehensive conservation strategies than Alternative A.

ALTERNATIVE C

The enhanced riparian and northern spotted owl conservation strategies of Alternative C might benefit gray wolf habitat throughout the plan area. Specifically, harvest restrictions within riparian areas and wetlands would maintain cover that might otherwise not be retained. Dense vegetation in these areas might provide cover for the wolves themselves, as well as forage and cover for their prey. It is likely that the relatively reduced disturbance associated with the northern spotted owl strategy of this alternative would benefit the gray wolf.

Although no proactive consideration is given to wolves or public access in DNR's road strategy in this alternative, there would be a mechanism to protect wolves if they are observed on DNR-managed lands. Site-specific plans would be developed in consultation with WDFW or USFWS to limit human disturbance within eight miles of a Class 1 gray wolf observation (see HCP). Disturbance would be limited in the area until five consecutive years pass without further observations. However, there is no process outlined for detecting such observations. Without at least minimal survey effort, it is unlikely that a Class 1 observation would occur, even if a wolf were present. Nonetheless, implementation of the enhanced conservation strategies of Alternative C would offer more protection of gray wolves, habitat for their prey, denning habitat, and potential connectivity with federal lands than Alternative A.

OESF ALTERNATIVES

This species does not occur within the OESF Planning Unit.

Grizzly Bear (*Ursus arctos*)

The grizzly bear is listed as federally threatened and state endangered in Washington. Potentially found throughout the Cascade Range from the Canadian border south into Yakima County and northeast to the Idaho border, grizzly bears occupy virtually all habitat types. Special habitats include wet meadows, swamps, bogs, streams, forested land, alpine meadows, and park lands (Brown 1985). The dispersion of habitats may also be critical, so that grizzly bears have access to a wide variety of vegetative and animal food sources (Servheen 1993). Steep sites where deep snows accumulate and persist through mid-winter warm periods have potential to be used by grizzlies for denning (Servheen 1993). Importantly, grizzly bear habitats are often relatively isolated from human disturbance and involve an aspect of cover. Although 90 percent of the radio relocations of bears (46 radio-collared bears) within the Yellowstone ecosystem were in forests that were too dense to permit observations of the bears, only 1 percent of the relocations in dense forests were farther than 1 kilometer (0.62 miles) from an opening (Blanchard 1978). One of the most important aspects of grizzly bear habitat management is road density, because grizzly bears tend to avoid habitat near roads, and roads expose grizzly bears to direct human-related mortality (Servheen 1993; Paquet and Hackman 1995 and references therein). There was one grizzly bear observation in 1990 within the plan area (WDFW Natural Heritage GIS data from 1990-93). Overall, approximately 190 square miles of plan area are within the 9,565 square miles of the North Cascades Grizzly Bear Recovery Zone. DNR-managed lands in the planning area are thought to potentially provide lower-elevation spring habitat for grizzly bears. The plan area may contribute significant attributes that raise its relative importance to the recovery zone.

A substantial amount of post-emergence habitat occurs in low-elevation areas at the edge of the recovery zone. As of 1993, there were 104 Class I and Class II sightings in the Washington Cascades (Almack 1993). The locations of the North Cascades grizzly bear observations are widely distributed throughout the ecosystem. Locations and timing of locations indicate at least some of the grizzly bears in the local population are resident to the Washington Cascades, including reproductive females. The Service believes that higher open-road densities and minimal hiding cover could result in mortality and harassment of bears during a tenuous period in a natural-recovery process.

ALTERNATIVE A

Conservation of the grizzly bear is guided by FRP Policies (Nos. 20, 21, 22, and 23) that mandate general protection for riparian areas, no net loss of wetland acreage or function, endangered and threatened species protection, and upland wildlife habitat maintenance. When fully implemented, these policies might provide foraging, travel, resting, and hiding opportunities for grizzly bears through the improved function of the riparian ecosystems, including wetlands. A SEPA environmental checklist would be undertaken for harvesting, road construction, or site preparation within one mile of a WDFW documented den site between October 1 and May 30, or within 0.25 miles at other times (WAC 222-16-80b). However, no proactive mitigation for identifying potential den sites is included, such as a map-based strategy displaying potential snow accumulation and persistence to indicate areas where preventative caution may be needed to avoid inadvertent harm to the species. Given that much of the area managed by DNR in the recovery zone is considered likely to be lower-elevation spring habitat, this omission may not pose substantial risk to the species. However, unrestricted seasonal activities near primary habitats would increase disturbance to grizzly bears. Most importantly, no specific consideration would be given to grizzly bears or public access in DNR's road strategy under this alternative. Conservation of grizzly bears and their habitat would be governed by Section 9 of the ESA.

ALTERNATIVE B

Improved wildlife habitat conditions afforded by the west-side riparian and northern spotted owl conservation strategies under this alternative might benefit grizzly bears. Increased hiding, resting, and travel cover (maintenance of debris and mature forest conditions) might improve access to prey/forage habitat (within harvest units and along west-side riparian areas). The specific buffer distances and harvest restrictions applied to riparian management zones, wind buffers, and wetland buffers would result in higher riparian ecosystem quality than Alternative A, perhaps increasing their value to grizzly bears as travel corridors and hiding cover. In addition, protection of talus slopes, caves, and cliffs might provide important shelter opportunities for grizzly bears. The spatial arrangement of spotted owl habitat in proximity to federal forests might provide grizzly bears with further travel opportunities which might facilitate access to diverse foraging opportunities.

Because no proactive provisions to limit access or reduce road density are incorporated in this alternative, the benefits of increased habitat suitability in this alternative over Alternative A may not be fully realized. High active road densities, where present, could decrease the probability that grizzly bears would occupy DNR-managed lands in those areas where this occurs. Harvesting and road construction near primary habitats such as avalanche chutes and meadows where no visual screening is left could negate the value of the habitats. Similarly, unrestricted seasonal activities near primary habitats could also increase disturbance to present but undetected grizzly bears.

However, there would be mechanisms to protect bears if they were observed on DNR-managed lands including adherence to established state policies. A SEPA environmental checklist would be undertaken for harvesting, road construction, or site preparation within one mile of a WDFW documented den site between October 1 and May 30, or within 0.25 miles at other times (WAC 222-16-80b, see Alternative A). Additionally, site-specific plans would be developed in consultation with WDFW or USFWS to limit human disturbance within 10 miles of a Class 1 grizzly bear observation until five consecutive years pass without a grizzly bear Class 1 observation in the area. Without at least minimal survey effort, there is the potential that a Class 1 observation would not occur, even if a grizzly bear was present. Overall, Alternative B's site-specific plans would provide the potential for increased protection for grizzly bears and their habitat over Alternative A.

ALTERNATIVE C

The more comprehensive riparian and northern spotted owl conservation strategies of Alternative C would enhance grizzly bear habitat throughout the plan area. Specifically, harvest restrictions within riparian management zones and wetland buffers would provide hiding cover that might otherwise not be maintained. Dense vegetative cover provides security near forage areas for bears. Enhanced salmonid strategies could directly benefit grizzlies by providing habitat conditions that would aid salmonid recovery, thereby increasing the food supply available for pre-hibernation fattening. The relatively lessened disturbance associated with the northern spotted owl strategy of this alternative would likely benefit the grizzly bear over Alternatives A and B.

Concerns about road densities, seasonal activities in areas with undetected bears, and lack of use surveys are the same as Alternative B. Established state policies would also similarly provide mechanisms to protect bears if they were observed on DNR-managed lands (see Alternative B). In this alternative, greater conservation of the grizzly bear and its habitat is suggested compared to Alternatives A and B, and more confidence of effective conservation is suggested by this alternative than Alternative B, due to the combined effect of the conservation strategies that could improve ecosystem function and therefore grizzly bear habitat. However, as with the other alternatives, the realized value of this alternative may be marginal due to the lack of consideration for grizzly bears in road management strategies outside of areas of known sitings.

OESF ALTERNATIVES

This species does not occur within the OESF Planning Unit.

4.5.2 Unlisted Fish and Wildlife Species

In the following analysis of federal and state candidate species, federal species of concern, and other sensitive fish and wildlife species, brief descriptions of the biology and life history requirements of each species are presented before assessing the effects of the alternatives. A more comprehensive description of the species' biology and life history requirements, as well as their current federal and/or state status, is provided in Chapter III of the draft HCP.

This analysis addresses the effects of the spotted owl and, to a limited extent, the marbled murrelet strategies, riparian ecosystem strategies, protection strategies for uncommon habitats, and species-specific protection measures, on particular unlisted species. For the west-side planning units, the effects of the alternatives are discussed, and action alternative effects are compared to the No Action alternative for each species whose range may include all or part of these planning units. For the OESF Planning Unit, analyses and comparisons are presented, as stated above, for the OESF No Action alternative, and Alternatives 2 and 3, for species whose range may include all or part of this planning unit. This analysis does not include the three east-side planning units because DNR is not seeking coverage for unlisted species east of the Cascade crest.

The No Action alternative for the five west-side planning units and the OESF Planning Unit reflects DNR's current land management activities under state and federal regulations, and its Forest Resource Plan policies. Alternatives B and C contain strategies for owl, murrelet and riparian protection that differ from the No Action alternative. However, the owl and riparian conservation strategies under Alternative C provide greater amounts of late seral forest condition, owl dispersal habitat, and riparian protection than Alternative B, and may be of more benefit to unlisted species. The provisions to protect uncommon habitats and additional species-specific protection measures for unlisted species are the same for both Alternatives B and C. The OESF action alternatives contain the same provisions as Alternatives B and C for protection of uncommon habitats, however, species-specific protection measures are not as extensive. The OESF owl conservation strategies differ between Alternatives 2 and 3, and are different from all west-side planning unit alternatives. The OESF riparian strategies are the same for Alternatives 2 and 3, but generally provide greater protection of the riparian ecosystem than Alternatives B and C.

A summary of conservation and protection measures by alternative is provided in Matrices 4.5.1a and 4.5.1b.

Matrix 4.5.2a: Management strategies for HCP (excluding OESF)

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Unlisted Species			
West-side units	Protection will be provided according to state regulations. Additional protection may occur in DNR-designated Natural Area Preserves and Natural Resource Conservation Areas. No specific provisions for unlisted species except for the northwestern pond turtle, sandhill crane, and western grey squirrel under the Washington Forest Practices Act (WAC 222-16-080(1) Unlisted species may be protected through development of wildlife habitat objectives required under FRP Policy No. 22.	Protection will be provided according to state regulations. Additional protection may occur in DNR-designated Natural Area Preserves and Natural Resource Conservation Areas. Unlisted species protected through spotted owl, marbled murrelet, and riparian conservation strategies, protection of uncommon habitats, and additional mitigation for particular species as follows: (1) harlequin duck: no activity allowed that would appreciably reduce likelihood of nesting success within 165 feet of a known active nest between May 1 and September 1; (2) northern goshawk: no activity allowed that would appreciably reduce likelihood of nesting success within 0.55 mile of a known active nest between April 1 and August 31; (3) common loon: no activity allowed that would appreciably reduce likelihood of nesting success within (continued)	Same as Alternative B.

	Alternative A No Action	Alternative B Proposed HCP	Alternative C
Unlisted Species (continued)			
West-side units (continued)		500 feet of a known active nest between April 1 and September 1; (4) Vaux's swift: trees and snags known to be used as night roosts will not be harvested; (5) myotis bats: trees and snags known to be used as communal roosts or maternal colonies will not be harvested; and, (6) California wolverine and Pacific fisher: no activity allowed that would appreciably reduce likelihood of denning success within 0.5 mile of a known active den between January 1 and July 31 (for wolverine) or February 1 and July 31 (for fisher).	

Matrix 4.5.2b: Management strategies for alternatives related to the OESF planning unit

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Unlisted Species			
Unlisted Species	Protection will be provided according to state regulations. Additional protection may occur in DNR-designated Natural Area Preserves and Natural Resource Conservation Areas. No specific provisions for unlisted species. Unlisted species may be protected through development of wildlife habitat objectives required under FRP Policy No. 22.	Protection will be provided according to state regulations. Additional protection may occur in DNR-designated Natural Area Preserves and Natural Resource Conservation Areas. Unlisted species protected through spotted owl, marbled murrelet, and riparian conservation strategies, landscape-level management planning, and protection of uncommon habitats. Conservation primarily derives from integrated, ecosystem-oriented management, rather than directing the nature of that management. Additional mitigation: (1) Vaux's swift: trees and snags known to be used as nests or night roosts will not be harvested; (2) Myotis bats: trees and snags known to be used as communal roosts or maternal colonies will not be harvested; and, (continued)	Protection will be provided according to state regulations. Additional protection may occur in DNR-designated Natural Area Preserves and Natural Resource Conservation Areas. Same as Alternative 2, except conservaton of upland wildlife that are associated with older forests will be concentrated in the owl zones.

	Alternative 1 No Action	Alternative 2 Unzoned Forest Proposed OESF	Alternative 3 Zoned Forest
Unlisted Species (continued)			
Unlisted Species (continued)		(3) Fisher: within 0.5 mile of a known active den between February 1 and July 3, no activity that would appreciably reduce likelihood of denning success. Exceptions to the additional mitigation restrictions related to nesting and roosting are limited to formal, experimental studies designed to address information needs related to integrating conservation and production or as other exceptional circumstances warrant.	

Molluscs

Three species of molluscs that may occur in the HCP planning area are currently species of concern to the U.S. Fish and Wildlife Service (61 Fed. Reg. 7457 (1996); USFWS 1996). Distribution and habitat requirements are not well understood for many aquatic molluscs; therefore, for the purposes of this analysis, all habitat needs for these species are assumed to be met in aquatic environments where they have been observed.

Newcomb's Littorine Snail (*Algamorda newcombiana* [a.k.a. Littorina {*Algamorda*} *subrotunda*]).

Newcomb's littorine snail is an estuarine species that is known to occur near the high-tide mark in *Salicornia* spp. salt marshes near Grays Harbor in the South Coast Planning Unit (T. Burke, WDFW, Olympia, WA, pers. commun. to C. Turley, DNR, Olympia, WA, 1994).

ALTERNATIVE A AND ACTION ALTERNATIVES

All DNR-managed lands within the HCP area adjacent to estuarine habitat such as the salt marshes of Grays Harbor and Willapa Bay are Natural Area Preserves (NAP). As such, the habitat required by Newcomb's littorine snail is expected to be protected under all alternatives. If this snail species should be discovered in the future in estuarine habitat that is not an NAP, it is likely that protection of Newcomb's littorine snail habitat would be provided as described below.

ALTERNATIVE A

The riparian ecosystem on DNR-managed lands is expected to provide some protection of the estuarine and wetland habitats primarily by the establishment and protection of riparian management zones on Type 1 through 4 Waters, and the establishment and protection of wetland management zones (WMZs) on all nonforested wetlands. Estuaries are Type 1 Waters and receive the same protection as other Type 1 Waters. Because the Newcomb's littorine snail occurs in marshes which are often associated with estuaries the establishment of, and restrictions on timber management activities within, WMZs directly protect essential habitats for this species.

ALTERNATIVES B AND C

Protection of this species would increase substantially under each of the HCP alternatives because the minimum buffer width for streams likely to empty into Grays Harbor (Type 1 through 4) would be 100 feet; it would average 150 feet for Type 1 through 3 Waters. These buffers would include a minimum 25-foot no-harvest zone. Additional wind buffers would be added in areas where there is a moderate potential for windthrow. Activities within the remainder of the riparian management zones would be limited to those that are expected to maintain or restore the quality of salmonid habitat. Thus, it is expected that other aquatic species such as the Newcomb's littorine snail would benefit from the conservation measures developed in these alternatives for the protection of salmonids. This protection would be greater than under the No Action alternative because of the 25-foot no-harvest provision, protection of unstable slopes, and the guaranteed wider protective zones on each side of Type 1 through 4 Waters. These provisions should result in more natural levels of sediments, organic nutrients and large woody debris

(LWD) flowing into the estuaries from inland areas than what would occur under the No Action alternative.

OESF Alternative 1 and Action Alternatives

The Newcomb's littorine snail is not expected to occur in the OESF. Thus, an assessment of the OESF No Action and action alternatives is unnecessary.

California Floater (*Anodonta californiensis*) and Great Columbia River Spire Snail (*Fluminicola columbiana*)

The California floater and the great Columbia River spire snail both inhabit medium to large rivers. Due to the similarities in habitat requirements of these species, the assessment of the effects of the alternatives on these species has been combined.

The California Floater

The California floater is a freshwater clam that inhabits medium- to large-sized rivers and creeks including the Columbia, Wenatchee, and Okanogan Rivers (T. Burke, WDFW, Olympia, WA, pers. commun. to C. Turley, DNR, Olympia, WA, 1994).

The Great Columbia River Spire Snail

The great Columbia River spire snail is a freshwater species that occurs in the Methow and Okanogan Rivers (Columbia, Klickitat, and possibly within the Chelan Planning Unit), although historically this species was widespread throughout the Columbia River system (Neitzel and Frest 1993). This species also occurs in other rivers in eastern Washington, Oregon, and Idaho, but is restricted to rivers and large streams with ample oxygen. The Methow River is the smallest stream that the Great Columbia River spire snail is known to inhabit (Columbia and Klickitat planning units).

Alternative A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide some protection of the aquatic habitats considered important to the California floater and the great Columbia River spire snail. This protection would be provided primarily through the establishment and protection of riparian management zones on all Type 1 through 3 Waters on DNR-managed lands according to DNR's FRP policies. In the recent past, riparian management zones for Type 1 and 2 Waters have averaged 196 feet (range = 0-350 feet), and for Type 3 Waters the average has been 89 feet (range = 0-300 feet). On average, approximately 77 percent of the riparian management zones have had no timber management activity. However, Type 4 and 5 Waters have received considerably less protection; riparian management zones on Type 4 Waters have averaged 52 feet (range = 0-300 feet), and 53 percent of Type 5 Waters have received no riparian protection. These small or non-existent riparian management zones could contribute to poor water quality in the larger rivers downstream. Under this alternative, additional protection of large rivers and creeks would be provided through the identification of, and prohibition of timber harvest on, unstable slopes, and through protection of salmonid spawning, rearing, and overwintering areas as identified by an analysis of watersheds during landscape planning (WFPB 1995b). However, some impacts to the aquatic habitat upon which these species rely may occur because the level of riparian management zone protection described above may range to zero on all water types, and the protection is not guaranteed.

ALTERNATIVE B

The management designed for protection of the riparian ecosystem under this alternative is expected to provide adequate guaranteed protection of the aquatic habitats considered important to the California floater and the great Columbia River spire snail where they occur on the west-side. Specific benefits of this alternative for aquatic species include the establishment of riparian management zones on all Type 1 through 4 Waters. Type 1 through 3 Waters would have buffers of approximately 150 feet with 50- to 100-foot buffers on the windward side. Protection of aquatic habitat is provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmonid habitat. This alternative would continue to include the No Action alternative protection of aquatic habitats which includes the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Under Alternative B, these protective measures would contribute to a higher quality of aquatic habitat than what occurs under the No Action alternative because of the riparian management zone guarantees, which include minimum buffer widths, generally wider buffers, additional wind buffers, and a no-harvest zone.

ALTERNATIVE C

The management designed for protection of the riparian ecosystem under Alternative C is expected to provide a substantial amount of guaranteed protection of the aquatic habitats considered important to the California floater and the great Columbia River spire snail. Specific benefits of this alternative for aquatic species include the establishment of riparian management zones on all Type 1 through 5 Waters. Type 1 through 3 Waters would have buffers of approximately 150 feet, with additional 100-foot wind buffers on each side of Type 1 and 2 Waters. Each side of a Type 3 Water greater than 5 feet wide would have a 50-foot wind buffer. Protection of aquatic habitat is provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to restore and enhance the quality of salmonid habitat. This alternative would continue to include the No Action alternative protection of aquatic habitats which includes the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). The protection of aquatic habitat would be substantially greater under this alternative than under the No Action alternative because of the riparian management zone guarantees, which include minimum buffer widths, generally wider buffers on all waters, additional wind buffers, and a no-harvest zone. In addition, under this alternative, management in the riparian management zones must restore or enhance salmonid habitat, which would maintain high quality aquatic habitat in the larger rivers and streams.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The California floater and the great Columbia River spire snail are not expected to occur in the OESF. Thus, an assessment of the OESF No Action and action alternatives is unnecessary.

Arthropods

Seven species of arthropods known to occur, or that may occur, in the HCP planning area are currently species of concern to the U.S. Fish and Wildlife Service (61 Fed. Reg. 7457 (1996) or candidates for state listing. An analysis of the effects of the alternatives on these species is discussed in the sections below.

Beller's Ground Beetle (*Agonum belleri*), Long-horned Leaf Beetle (*Donacia idola*), and Hatch's Click Beetle (*Eanus hatchii*)

The Beller's ground beetle, long-horned leaf beetle, and Hatch's click beetle are known to inhabit eutrophic sphagnum bogs (i.e., nonforested wetlands) in or near low elevation (less than 3,300 feet) lakes (i.e., Type 2 Waters) (Dawson 1965; Rodrick and Milner 1991). Since these species have similar habitat requirements, the analysis of the effects of the alternatives on these species has been combined.

Beller's Ground Beetle

Beller's ground beetle occurs exclusively in lowland sphagnum bogs of Washington, Oregon, and southwestern British Columbia (Johnson 1979, 1986). In Washington, Beller's ground beetle is only known to occur in Snoqualmie Bog, now a DNR Natural Area Preserve (NAP), located along the north fork of the Snoqualmie River, and in Kings Lake Bog NAP (Crawford 1994; R. Crawford, University of Washington, Seattle, pers. commun., 1993).

Long-horned Leaf Beetle

The long-horned leaf beetle occurs specifically in lowland sphagnum bogs of Washington and southwestern British Columbia (Rodrick and Milner 1991). In Washington, this species has been documented historically only in Snohomish County, and is currently known to occur in only one locale, Chase Lake, near Edmonds (R. Crawford, University of Washington, Seattle, pers. commun., 1993). Long-horned leaf beetle larvae forage on submerged plants, while adults forage on the exposed portions of aquatic plants (White 1983).

Hatch's Click Beetle

Hatch's click beetle occurs exclusively in lowland sphagnum bogs of northwestern Washington (Johnson 1979). This species is known to occur historically in Snohomish and King Counties, but is currently only known to occur at three bog sites located in central King County, including Kings Lake Bog NAP (WDFW 1994a; Crawford 1994; R. Crawford, University of Washington, Seattle, pers. commun., 1993). Adult beetles feed on honey, dew, pollen, nectar, and small soft insects (WDFW 1994a).

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide some protection of the sphagnum bog habitat in which these three species of beetles occur. Protection of sphagnum bogs would occur primarily through the restriction of timber management activities within wetland management zones (WMZs) that would be established around nonforested wetlands according to DNR's Forest Resource Plan (FRP) policies (DNR 1992b). Wetland management zones on nonforested wetlands in the recent past have averaged 86 feet; a policy that is expected to continue, and would be applied to all bogs greater than or equal to 0.25 acre in size.

DNR's FRP policies to control undesirable vegetation, insects, disease, specifies a hierarchical approach with direct application of herbicides and pesticides being the least preferred alternative. For example, during the last 10 years, DNR did not use any aerial insecticides (DNR 1992b). DNR balances economic, biological, environmental, and social views in determining the best approach to prevent resource damage. These policies and the establishment of WMZs should provide adequate protection of the habitat upon which these beetle species rely. In addition, habitat known to be occupied by the Beller's ground beetle and Hatch's click beetle would continue to be protected in the Natural Area Preserves.

Alternative B

Management of the riparian ecosystem under this HCP alternative is expected to provide adequate protection of the sphagnum bog habitat in which these three species of beetles occur. This protection is expected to be achieved primarily through the establishment of wetland buffers greater than or equal to 100 feet on all bogs greater than or equal to 0.25 acres, which is greater than current practices under Alternative A. Also, habitat known to be occupied by the Beller's ground beetle and Hatch's click beetle would continue to be protected in the Natural Area Preserves. DNR's FRP policies regarding the use of herbicides and pesticides would continue, which is the same as under the No Action alternative.

Alternative C

Management of the riparian ecosystem under this HCP alternative is expected to provide somewhat more protection of sphagnum bog habitat than Alternatives A or B. This protection is expected to be achieved primarily through the establishment of wetland buffers greater than or equal to 100 feet on all bogs greater than or equal to 0.1 acre. A no-harvest restriction would be in effect for the first 50 feet from the wetland's edge. This protection would be greater than the No Action alternative because of the guaranteed protection zones, and the no-harvest restriction in the wetland buffers. Also, habitat known to be occupied by the Beller's ground beetle and Hatch's click beetle would continue to be protected in the Natural Area Preserves. However, policies regarding the use of herbicides and pesticides would be according to DNR's FRP, which is the same as under the No Action alternative.

OESF Alternative 1 and Action Alternatives

No effects are anticipated to the Beller's ground beetle, long-horned leaf beetle, or the Hatch's click beetle under any of the OESF alternatives because these species are very localized in distribution and are not expected to occur on the Olympic Peninsula.

Columbia River Tiger Beetle (*Cicindela columbica*)
The Columbia River tiger beetle occurs exclusively along sandy shoreline habitats of the Columbia and Snake Rivers (R. Crawford, University of Washington, Seattle, pers. commun., 1993). This species is thought to be extinct along dammed areas, but may occur along the Hanford reach or along Hell's Canyon (R. Crawford, University of Washington, Seattle, pers. commun., 1993). For the purposes of this analysis, all habitat needs for this species are assumed to be met within the sandy shoreline habitats along the Columbia and Snake Rivers.

ALTERNATIVE A AND ACTION ALTERNATIVES
Within the defined HCP area (the range of the northern spotted owl), there are no DNR-managed lands adjacent to the shores of the Columbia River. Therefore, no direct protection measures for this species or its sandy river shoreline habitat are currently being implemented, nor have any protective measures been incorporated into any of the proposed alternatives.

Fender's Soliperlan Stonefly (*Soliperla fenderi*) **and Lynn's Clubtail** (*Gomphus lynnae*)
The Fender's soliperlan stonefly is known from only one locale in Washington, thus, information on habitat needs and geographic range are limited for this species. Occurrences of Lynn's clubtail also are localized. The habitat requirements for these species are similar; both utilize aquatic habitats (i.e., Type 1 through 5 Waters). Thus, for purposes of this assessment, all habitat needs for these species are assumed to be met within these habitats, and the effects of the alternatives on these species have been combined.

Fender's Soliperlan Stonefly
One specimen of the Fender's soliperlan stonefly was collected from St. Andrew Creek in Mount Rainier National Park (J. Lattin, Oregon State University, Corvallis, pers. commun., 1994). Based on the biology of related species of stoneflies and the location at which the only observation of the Fender's soliperlan stonefly was recorded, all habitat requirements are assumed to occur within and adjacent to aquatic habitats.

Lynn's Clubtail
This species of dragonfly is known primarily to use large rivers, but has also been recorded in mountain lakes (i.e., Type 2 Waters) (J. Lattin, Oregon State University, Corvallis, pers. commun., 1994). Lynn's clubtail occurs primarily east of the Cascades, and has been reported to occur along the Yakima River from Kiona, Washington to Richland, Washington. Lynn's clubtail uses silty water for breeding. This species tends to occur along low-elevation streams or rivers with a fair amount of siltation (J. Lattin, Oregon State University, Corvallis, pers. commun., 1994).

ALTERNATIVE A
These two species are not known to occur on DNR-managed lands within the range of the spotted owl. However, should they occur in the HCP area, current management of the riparian ecosystem on DNR-managed lands is expected to provide some protection of the aquatic habitats considered important to the Fender's soliperlan stonefly and Lynn's clubtail. This protection is expected to occur primarily from the establishment and

protection of riparian management zones on all Type 1 through 3 Waters according to FRP policies. The riparian management zones have averaged 196 feet on Type 1 and 2 Waters, and 89 feet on Type 3 Waters, although some of these waters have had no riparian management zones. Additional protection of aquatic habitats is provided through the identification of, and prohibition of timber harvest on, unstable slopes, and through protection of salmonid spawning, rearing, and overwintering areas as identified by an analysis of watersheds during landscape planning (WFPB 1995b). The use of herbicides and pesticides would be according to DNR's FRP policies, as described above in the analysis of effects on the beetle species.

ALTERNATIVE B

The management designed for protection of the riparian ecosystem under Alternative B is expected to provide adequate protection of the aquatic habitats considered important to the Fender's soliperlan stonefly and Lynn's clubtail, should they occur on DNR-managed lands in the HCP area. Specific benefits of this alternative include the establishment of riparian management zones on Type 1 through 4 Waters. Riparian buffers on Type 1 through 3 Waters would be based on sight potential tree height or 100 feet whichever is greater (averaging 150 feet) plus a wind buffer on the windward side where there is a moderate potential for windthrow. Type 4 Waters would have 100-foot riparian buffers. Protection of riparian management zones is provided by a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmonid habitat (i.e., large woody debris, stream temperature, water quality). This alternative would continue to include the No Action alternative protection of aquatic habitats which includes the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). However, protection of aquatic habitat would be greater under this alternative than under the No Action alternative because of the riparian management zone guarantees, which include minimum buffer widths, generally wider buffers, additional wind buffers, and a no-harvest zone.

ALTERNATIVE C

The management designed for protection of the riparian ecosystem under Alternative C is expected to provide substantial protection of the aquatic habitats considered important to the Fender's soliperlan stonefly and Lynn's clubtail should they occur on DNR-managed lands in the HCP area. Specific benefits of this alternative include the establishment and protection of riparian management zones on all Type 1 through 5 Waters. Stream buffers would be based on sight potential tree height or 100 feet, whichever is greater. Additional wind buffers of 100 feet would be established on each side of Type 1 and 2 Waters. Each side of a Type 3 Water greater than 5 feet wide would have a 50-foot wind buffer. Protection of the aquatic habitat would be provided by a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to restore or enhance the quality of salmonid habitat. This protection, and the riparian management zone guarantees, which include minimum buffer widths, generally wider buffers on all waters, additional wind buffers, and a no-harvest zone would contribute to maintenance of stream quality and is substantially greater than that provided under the No Action alternative.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

Fender's soliperlan stonefly and Lynn's clubtail are unlikely to occur on the Olympic Peninsula. However, should they occur, adequate protection would be provided under the OESF No Action and action alternatives. Current management of the riparian ecosystem in the Olympic Region of DNR places mass-wasting buffers along streams. These buffers have averaged at least 94 feet on Type 1 through 5 Waters. Minimal timber management activity is allowed in these buffers or in areas identified as unstable. An additional layer of guaranteed protection of aquatic habitat for this species is assured through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b).

The OESF action alternatives would have the same riparian management strategy. Riparian management zones would consist of an inner mass-wasting buffer and an outer wind buffer. It is anticipated that the inner-core buffers would average 150 feet on Type 1 and 2 Waters, and 100 feet on Type 3 and 4 Waters. A 150-foot wind buffer would be added along both sides of Type 1, 2, and 3 Waters, and a 50-foot wind buffer would be added along Type 4 and 5 Waters. This riparian management strategy would provide substantial protection of the habitat upon which these species rely, and would be guaranteed, which is greater than that provided under the OESF No Action alternative.

Johnson's (mistletoe) Hairstreak (*Mitoura johnsoni*)

Johnson's (mistletoe) hairstreak, a candidate for state listing, is a butterfly whose larvae are dependent upon species of dwarf mistletoe (*Arceuthobium spp.*), which occur primarily on western hemlock (*Tsuga heterphylla*) (Pyle 1989; Larsen et al. 1995). This butterfly is known to occur in low-elevation, late-successional forests west of the Cascade crest and on the Olympic Peninsula. It occurs in mature hemlock and Douglas-fir (*Pseudotsuga menziesii*) forests infested with dwarf mistletoe, where adults are known to feed on nectar sources that include dogwood (*Cornus nuttallii*) and oregongrape (*Berberis nervosa*) (Pyle 1974). Loss of late-successional forests, insecticide use, and mistletoe suppression are thought to be detrimental to Johnson's (mistletoe) hairstreak (Larsen et al. 1995).

ALTERNATIVE A

Current policies to manage late-successional forests for spotted owls and marbled murrelets will provide habitat for Johnson's (mistletoe) hairstreak, however, the amount of habitat is likely to decline as timber harvests reduce habitat unoccupied by spotted owls or marbled murrelets. Presently DNR manages 34,826 acres in forest greater than or equal to 200 years old and 150,978 acres between 70-200 years of age in the five west-side planning units, which is considered the potential spotted owl habitat in these units. Under Alternative A, 79,079 acres of this potential habitat will be protected throughout the planning period and is projected to increase slightly to 81,178 acres by the year 2096. While consistent with federal regulations, this decline in potential spotted owl habitat (from 185,803 acres) is likely to result in a decline in hairstreak habitat, but may protect some of the existing old-growth forest on DNR-managed lands. If these butterflies depend on existing old growth as source habitats then Alternative A may provide some support for this species.

ALTERNATIVE B

Under this alternative, 65,657 acres of potential spotted owl habitat will be designated to occur within 8 miles of federal land reserves in the western Washington units. This represents a decline from Alternative A, and may represent a decline in hairstreak habitat as well. Potential habitat for spotted owls increases to 81,621 by the year 2096 under this alternative, but the suitability of regenerated stands and the adequacy of their distribution for this butterfly is unknown. Under Alternative B, there would be less old-growth and mature stands in 2096 than under Alternative A, which likely would result in greater impacts to Johnson's hairstreak butterfly than the No Action alternative.

ALTERNATIVE C

Under this alternative, 80,497 acres of potential spotted owl habitat would occur within 8 miles of federal land reserves in the western Washington units. This designation is similar to Alternative A in the amount of habitat it maintains, which may represent potential Johnson's (mistletoe) hairstreak habitat as well. This alternative would increase potential spotted owl habitat to 146,098 acres by the year 2096. Although this would be an increase in habitat over what will be provided under Alternative A, the same concerns about the suitability of regenerated stands and the adequacy of their distribution for this butterfly, as stated in Alternative B, would exist. Alternative C may provide the most support for the hairstreak if habitat suitability and distribution are adequate, and if this habitat can be colonized by the species throughout the planning period. If not, protection for Johnson's hairstreak butterfly under Alternative C would likely be less than under the No Action alternative.

OESF ALTERNATIVE 1

The No Action alternative would provide some late-successional habitat for the Johnson's (mistletoe) hairstreak via habitat protections for spotted owls and marbled murrelets. This includes 15,000 acres of suitable habitat that is deferred from harvest until 2005. Riparian buffers, while minimal, may provide additional late-successional habitats in low-elevation areas. The amount of current capable spotted owl habitat available under this plan is projected to decline from 48,900 acres to 36,800 (in year 2096) as unoccupied owl circles, marginal murrelet sites, and stands not occupied by owls or murrelets are harvested; currently capable habitat consists of forests as young as 70 years old. Although some late-successional forests would be protected and regenerated, this alternative lacks proactive attempts to regenerate well-distributed, late-successional forests that appear critical for this species.

OESF ALTERNATIVE 2

Under the unzoned alternative, 153,400 acres of predicted capable spotted owl habitat would be available in year 2096, approximately 20 percent of which would be old forest habitat available throughout the planning period. Old forest is defined as a forest that has characteristics of, and functions as, late successional forest and may possibly be developed through management. While providing old-forest habitats is emphasized in this plan, habitat quality may be limited by the degree of mistletoe infestation in regenerating stands. Further, the degree of butterfly habitat connectivity that would result is unknown. However, the unzoned alternative appears to provide the greatest amount of potential hairstreak habitat that would be well distributed throughout the OESF.

OESF Alternative 3

Under the zoned alternative, predicted capable spotted owl habitat will be compartmentalized into a number of zones, and will amount to 97,200 acres in the year 2096. Although this alternative provides 5000 acres of old growth in owl nest groves, it is unclear how much older forest habitat would be available throughout the planning period or its suitability for Johnson's hairstreak butterfly. However, the total amount of capable owl habitat is less than that predicted for the unzoned alternative and likely would provide less habitat for this butterfly species. The habitat amounts provided in the zoned alternative would exceed those in the No Action alternative, but the suitability of the habitat and its distribution is unknown.

Fish (excluding Pacific salmon (*Oncorhynchus*) which are covered in a separate section beginning on p. 4-383)

Five fish species, excluding anadromous salmonids, are federal candidates for listing or species of concern to the U.S. Fish and Wildlife Service and are known to occur within the bounds of the west-side HCP planning units. One of these, the Olympic mudminnow, is also a candidate for listing by the state. All the spawning, juvenile and rearing habitats for three of these species are provided by the freshwater aquatic environment. River lampreys spawn and rear juveniles in freshwater but adults rear solely in the marine environment. There is no known green sturgeon spawning and juvenile habitat in Washington, though some adult rearing occurs in the Columbia River. The habitat requirements of these species are described below. Since some or all of these species' life requisites are provided by aquatic habitat types, the assessment of the effects of the riparian protection strategies under the alternatives on each of these species is combined.

Bull Trout (*Salvelinus confluentis*)

Bull trout are found throughout coastal and inland streams and lakes in Washington and are thought to occur throughout the HCP planning area. Although some individuals may spend their entire life in a small segment of a stream, most are highly migratory, traveling to headwater streams to spawn and later migrating back to larger stream segments or lakes to rear (McPhail and Murray 1979). Bull trout are most often associated with cool (36-39 degrees F), clear, mountain streams and lakes during spawning and incubation (WDFW 1994a). Streams utilized by this species are typically high-elevation headwaters fed by snowmelt or springs (Bond 1992; WDFW 1994a).

Five characteristics of rearing habitat are of primary importance to bull trout: channel stability, substrate composition, cover, temperature, and migratory corridors (Rieman and McIntyre 1993). Highest abundance of this species is attained in streams dominated by gravel and cobble (Bond 1992). This species is also associated with waters less than 64 degrees F (18 degrees C) in the summer (WDFW 1994a), but tends to occur in stream segments with temperatures below 59 degrees F (15 degrees C) (Rieman and McIntyre 1993). Because rearing habitat for juveniles includes the substrate or other protected areas, this species requires clean, mostly sediment-free bottom area or an abundance of large woody debris for cover (Rieman and McIntyre 1993). Sheltered pools with large organic debris and clean cobble substrate provide rearing habitat for adults (McPhail and Murray 1979).

Olympic Mudminnow (*Novumbra hubbsi*)
The Olympic mudminnow is restricted to drainages along the west coast of Washington, the Chehalis River, and the lower Deschutes River (Meldrim 1968; Harris 1974; Wydoski and Whitney 1979). Within this region, the species is restricted to the following areas: (1) freshwater habitats north of Grays Harbor; (2) Chehalis tributaries entering from the north and some adjacent stream mouths from the south; (3) the Chehalis River below Rainbow Falls; and, (4) the lowest reaches of the Deschutes River where it enters Puget Sound. The northernmost distribution of the Olympic mudminnow was documented around Lake Ozette (Harris 1974). Harris (1974) also indicated that this species was restricted to the coastal lowlands, and that it did not extend to the base of the Olympic Mountains in the Chehalis drainage.

Olympic mudminnows use similar habitats for spawning, and juvenile and adult rearing. Within its geographic range, spawning and rearing habitats for the Olympic mudminnow are highly restricted to ponds and marshy streams in coastal lowlands (WDFW 1994a) with the following characteristics: (1) relatively deep (at least several inches); (2) slow-flowing or still water; (3) choked with aquatic vegetation; and, (4) soft mud bottom (containing organic matter) (Hagen et al. 1972; Harris 1974; Wydoski and Whitney 1979). This species does not occur in newly silted areas containing inorganic sediment alone. Olympic mudminnows occur in a wide range of water quality conditions, but are found most often in turbid water. Although they prefer cooler waters, Olympic mudminnows also occur in water temperatures ranging from 32 to 70 degrees F (Wydoski and Whitney 1979).

Pacific Lamprey (*Lamptera tridentata*)
Pacific lamprey are found in coastal streams from southern California to the Gulf of Alaska. In Washington, this species is found inland in the Columbia, Snake, and Yakima River systems (Wydoski and Whitney 1979), and is thought to occur throughout the HCP planning area. Pacific lamprey travel up rivers and streams, sometimes several hundred miles, to the headwaters, where they spawn in cold water, depositing their eggs in clean sand, gravel (Wydoski and Whitney 1979; Brown 1985), and cobble substrates (U.S. Bonneville Power Administration et al. 1994). Kan (1975) found that the Pacific lamprey spawned predominantly in low-gradient stream segments, usually just above riffles at the tail end of pools at water depths of 0.4 to 1 meter (1-3 feet) (U.S. Bonneville Power Administration et al. 1994). Juvenile rearing habitat is found downstream from the redd where they hatched, typically in slow, cool, soft-bottomed stretches in back waters, pools, and quiet eddies (Kan 1975; Wydoski and Whitney 1979; Brown 1985) where they remain for a maximum of 5 to 6 years. At transformation, Pacific lampreys move out of the burrow and travel downstream in late summer during flood conditions, eventually reaching the sea or a lake which provides adult rearing habitat (Scott and Crossman 1973).

River Lamprey (*Lamptera ayresi*)
The river lamprey occurs in coastal streams from northern California to northern British Columbia and southeast Alaska. Little is known about the biology of this species. Similar to the Pacific lamprey, river lampreys probably spawn in low-gradient stream segments immediately upstream of riffles, using sand and gravel to excavate their redds

(Wydoski and Whitney 1979). Most river lamprey spawning habitat probably occurs in smaller headwater streams and rivers (Brown 1985). Juvenile rearing habitat for the river lamprey occurs in silt deposits in both riffle and pool habitats (Wydoski and Whitney 1979). Adult rearing habitat occurs in the Pacific Ocean, before the lampreys migrate to freshwater to spawn (Wydoski and Whitney 1979).

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide some protection of suitable spawning and rearing habitats for the bull trout, Olympic mudminnow, and Pacific and river lampreys. This habitat receives the protection provided primarily by the establishment and protection of WMZs on nonforested wetlands and of riparian management zones on all identifiable Type 1 through 5 Waters according to DNR's FRP policies. Based on a survey of timber sales sold on DNR-managed land since 1992, no timber management activity has occurred in 77 percent of the riparian management zones established on Type 1 through 5 Waters on DNR-managed land. Riparian management zones on smaller headwater streams used by bull trout have averaged 52 feet on Type 4 Waters, and 40 feet on 47 percent of Type 5 Waters. However, these zones have ranged as low as zero for both Type 4 and Type 5 Waters, and 53 percent of Type 5 Waters have had no buffer, thus some impacts to bull trout would expected under this alternative. Because spawning and rearing for the Olympic mudminnow is restricted to ponds and marshy streams which are often associated with wetlands, the establishment of, and restriction of timber management activities within, WMZs directly protects essential habitats for this species. The average width of WMZs has been 86 feet. In addition to the smaller headwater streams, Pacific and river lampreys also inhabit low gradient streams and large rivers. Riparian management zones on Type 1 and 2 Waters have averaged 196 feet, and riparian management zones on Type 3 Water have averaged 89 feet, although these zones have ranged as low as zero. These WMZs and riparian management zones, although not guaranteed, to some extent contribute to stream stability, and water temperature and quality, providing some protection of the spawning and rearing habitat of these fish species. In addition, protection will be provided through the identification of, and prohibition of timber harvest on, unstable slopes, and through protection of salmonid spawning, rearing, and overwintering areas as identified by an analysis of watersheds during landscape planning (WFPB 1995b). Protection of salmon habitat would likely protect the stream features and functions that most of these five non-salmonid candidate fish species require.

ALTERNATIVE B

Management of the riparian ecosystem under Alternative B is expected to provide adequate guaranteed protection of spawning and rearing habitats of the bull trout, Olympic mudminnow, and Pacific and river lampreys. Specific benefits of this alternative considered important to these species include the establishment of wetland buffers and riparian management zones on all identifiable Type 1 through 4 Waters. Riparian management zone widths would be one site potential tree (approximately 150 feet) or 100 feet whichever is greater on all Type 1 through 3 Waters. Riparian management zones on Type 4 Waters would be two-thirds of a site potential tree (approximately 100 feet). Type 5 Waters would receive protection according to DNR's

FRP policies, which would be the same as Alternative A. In addition, wind buffers of 50-100 feet would be added to the windward side of Type 1 through 3 Waters where there is a moderate potential for windthrow. Protection of aquatic habitat would be provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmonid habitat. Wetland buffers would be at least 100 feet on wetlands greater than or equal to .25 acre. Additional protection of aquatic habitats includes the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Under Alternative B, there would be greater protection than that provided under the No Action alternative because of the minimum buffer widths, wider buffers on Type 3 and 4 Waters and nonforested wetlands, guaranteed no-harvest restriction, and management that must maintain or restore salmonid habitat. Protection of salmon habitat would likely protect the stream features and functions that most of these five non-salmonid candidate fish species require.

ALTERNATIVE C

Management of the riparian ecosystem under Alternative C is expected to provide substantial guaranteed protection of spawning and rearing habitats of the bull trout, Olympic mudminnow, and Pacific and river lampreys. Specific benefits of this alternative considered important to these species include the establishment of wetland buffers and riparian management zones on all identifiable Type 1 through 5 Waters. Riparian management zones would be one site potential tree (approximately 150 feet) or 100 feet, whichever is greater, on Type 1 through 5 Waters. In addition, wind buffers of 100 feet would be added to both sides of Type 1 and 2 Waters, and 50-foot wind buffers would be added to each side of Type 3 Waters greater than 5 feet wide. Protection of the riparian management zone for aquatic species is provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to restore or enhance the quality of salmonid habitat. Wetlands protection would be the same as in Alternative B, except that Alternative C would also include 50-foot no-harvest buffers on nonforested wetlands, and 100-foot buffers on bogs greater than or equal to 0.1 acre in size. Additional protection of aquatic habitats includes the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). This protection is substantially greater than that provided under the No Action alternative because of the minimum buffer width, wider buffers on Type 3 through 5 Waters, additional wind buffers, guaranteed no-harvest restriction in riparian management zones and WMZs, and management that must restore or enhance salmonid habitat.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF is expected to provide adequate protection of spawning and rearing habitats of the bull trout, Olympic mudminnow, and Pacific and river lampreys. The Olympic Region of DNR currently places mass-wasting buffers along streams where needed. No timber removal or timber management activity occurs within these buffers or in areas identified as unstable. An additional layer of protection of aquatic habitat upon which these species rely is assured through the restriction of timber management activities within riparian management zones and wetland buffers which directly protect essential habitat for these species. Average riparian management zone widths on Type 1 through 5 Waters in the past have been 146, 136, 94, 96, and 105 feet, respectively. Wetland management Zones have averaged 86 feet in width, and no timber harvest activity has occurred in these buffers. Additional protection for the habitat upon which these species rely is provided by the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Protection of salmon habitat would likely protect the stream features and functions that most of these five non-salmonid candidate fish species require.

OESF Action Alternatives

Management of the riparian ecosystem would be the same under both OESF action alternatives, and would provide adequate protection of spawning and rearing habitats for the bull trout, Olympic mudminnow, and Pacific and river lampreys. Ecosystem protection under these alternatives would be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which are expected to benefit all aquatic species. Specific protection of aquatic habitat would occur primarily from the establishment of, and restriction of timber harvest activities in, riparian management zones and wetland buffers. These buffers would be applied in a site-specific manner and would consist of an inner mass-wasting buffer and an outer wind buffer. Total buffer widths on Type 1 and 2 Waters would average 300 feet. Buffers on Type 3 and 4 Waters would average 250 and 150 feet, respectively. Type 5 Waters would have inner buffers based on the identifiable channel and unstable slopes, and a variable outer buffer. These buffers may range from a minimum of 25 feet to 1,000 feet depending on site-specific conditions. Wetland buffers would be the same as those described in Alternative B above. Minimal timber management activity would be allowed in the mass-wasting buffer. Additional protection for the habitat upon which these species rely is provided by the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b).

Pacific Salmon

All seven species of pacific salmon (*Oncorhynchus* spp.) are found in western Washington lakes, rivers, and streams (Wydoski and Whitney 1979). These fish have become adapted to cool, clean water, with abundant gravels and a diversity of habitats composed of riffles and pools. Because salmon have evolved in a largely forested setting, many of their adaptations are associated with cool water temperatures, high oxygen concentrations, and large woody debris (LWD) habitat. Large woody debris is contributed to the aquatic systems from the riparian forest by such processes as stream bank erosion, wind damage, and slope failures (Hicks et al. 1991; FEMAT 1993). For the species that spend a limited amount of time in the freshwater environment (i.e., chum, pink, chinook), or rely on lakes for rearing (i.e., sockeye), cool water temperatures and high oxygen levels are very important, however LWD also plays a limited role in their life history strategies. For these species the importance of LWD is more narrowly focused on providing cover for adults and stabilizing the spawning beds for egg incubation. For the other species of salmon (i.e., coho, steelhead, cutthroat) that rear in freshwater for extended periods of time, LWD plays a greater role during both spawning and rearing. It contributes to channel stability during spawning, as well as forming rearing pools and riffles and contributing to food productivity. Large woody debris is also an important source of refuge cover for adults and juveniles during high flow conditions and when being sought after by predators.

Chum (*O. keta*)
Western Washington chum salmon are found close to saltwater, where they spawn in low-gradient tributaries or side channels of rivers. Being anadromous, this species spends part of its life in freshwater and the remainder in saltwater (Groot and Margolis 1991; Meehan and Bjornn 1991). During the initial stage of life, chum salmon eggs can be found incubating in coastal streams, while the adult phase of life is spent in the ocean. The length of time spent in the ocean can vary from 6 months to 4 years (Wydoski and Whitney 1979), while the time spent in freshwater is relatively short. The freshwater phase of a chum salmon's life is virtually over upon emergence from the gravel, as they swim down to the estuary and eventually to the sea almost immediately after emergence from the gravel. These fish rely on medium-sized spawning gravels that are relatively free of sand and silt (Koski 1975).

Pink (*O. gorbuscha*)
Pink salmon are found in just a few Puget Sound rivers and tributaries. Being anadromous, this species spends part of its life in freshwater and the remainder in the ocean feeding (Groot and Margolis 1991; Meehan and Bjornn 1991). Juvenile pink salmon use freshwater very briefly, as they migrate to the estuary and marine environment soon after emergence from the gravel. Pink salmon are unique in that they have a strict 2-year lifespan, and in Washington the odd year cycle is the most dominant (Wydoski and Whitney 1979). These salmon prefer to spawn during late summer in small- to medium-sized gravels (Wydoski and Whitney 1979).

Sockeye (*O. nerka*)
The majority of western Washington sockeye salmon are found in a few river systems that have accessible lakes, with a relatively minor portion found in systems without lakes. Most sockeye are anadromous, spending part of their life in freshwater and the remainder in saltwater (Groot and Margolis 1991; Meehan and Bjornn 1991). The freshwater stages of life are spent either in tributaries and rivers during egg incubation or in lakes and other standing bodies of water during the juvenile rearing stages. The adult feeding stages are spent in the ocean environment. The length of time spent in the ocean will vary from 1-3 years (Wydoski and Whitney 1979), with the period of freshwater residence taking from 1-2 years to achieve smolt size. Most sockeye adults enter freshwater to spawn in early to mid-summer, the adults hold in the lake through the fall, and eventually spawn in tributaries and along lake shorelines in late fall and early winter. Spawning occurs in clean small- to medium-sized gravels. After the young fry emerge from the gravel, they move into the lake for rearing for a couple years, where they feed on zooplankton and eventually migrate to sea as smolts. Kokanee are the non-anadromous variety of the sockeye salmon. Kokanee have similar spawning and rearing habits as the anadromous

form, however because it stays in the lake and does not go to sea, it doesn't achieve as large a size.

Chinook (*O. tshawytscha*)
Chinook salmon are found in all of the larger west-side river systems of Washington. Being anadromous, this species spends part of its life in freshwater and the remainder in saltwater (Groot and Margolis 1991; Meehan and Bjornn1991). The early freshwater stages of life are spent in the coastal rivers and tributaries, while the adult feeding stages are spent in the ocean environment. The length of time spent in the ocean will vary from 2-8 years (Wydoski and Whitney 1979), with most taking 3-5 years to reach adulthood. Chinook adults enter and spawn in freshwater between the months of March and December and this will vary depending on the particular variety of chinook (i.e., spring, summer, fall chinook). Spawning occurs in shallow- to deep-water streams where the eggs are deposited in medium- to large-diameter gravels. Upon emergence from the gravel, young chinook spend several months to a year in freshwater before migrating to the estuary and on to the sea. Juveniles rely on clean, cool, well-oxygenated water, with a good supply of food, and can be seen feeding in large schools throughout the lower rivers and estuaries during the summer months. Most chinook juveniles migrate (as smolt) to sea at the end of summer, however, a significant portion, especially the spring chinook, will remain in freshwater over one winter and smolt to sea the following spring. During winter residence, these juveniles have been observed burying themselves in gravel crevices or hiding within complex LWD jams, presumably to escape high velocity currents during winter and spring runoff (Bjornn 1971; Hicks et al. 1991; Groot and Margolis 1991).

Coho (*O. kisutch*)
Coho salmon are the most ubiquitous of the Pacific salmon, occurring in almost every accessible lake, river and stream in western Washington. Being anadromous, the coho spends part of its life in freshwater and the remainder in saltwater (Groot and Margolis 1991; Meehan and Bjornn 1991). The coho spends about a year and a half in freshwater, and 1-2 years in saltwater before returning to spawn as 3- to 4-year-old adults. Most coho adults enter freshwater to spawn in October through January, and the eggs incubate through the winter. Coho prefer to spawn in small- to medium-sized gravels in small streams; gravels should be free of unnaturally high levels of silt and sand (Tagart 1984). Fry emergence occurs from March through May depending on the particular river system. Most stream-dwelling juvenile coho reside in pool habitats as fry and fingerling for one summer where they feed on aquatic insects. In the winter, coho juveniles either reside in deep pools associated with LWD, or seek refuge from high flows in pond-headed or spring-fed tributaries (Cederholm and Scarlett 1981; Peterson and Reid 1984). Most yearling coho migrate to sea during the months of April through June.

Steelhead (*O. mykiss*)
Steelhead are found in most of the medium- to large-sized rivers and streams in western Washington. Steelhead are both anadromous and non-anadromous; the non-anadromous form is called the rainbow trout. There are two varieties of anadromous steelhead in Washington, the more abundant and widespread winter run, and the more restricted summer run. Steelhead spend from 1-4 years at sea, with most naturally produced

steelhead spending 2-3 years. Steelhead juveniles generally enter the marine environment after spending 2 years rearing in freshwater, however, it isn't uncommon to find 1and 3 year old smolts (Winter 1992). Juveniles prefer to reside in fast-running riffle and cascade habitats during the summer, but are also found in pool habitat associated with LWD during winter. In the winter juvenile steelhead are also found immigrating into gravel-bedded tributaries during periods of high stream flow (Cederholm and Scarlett 1982). Steelhead generally spawn in clean, small-to medium-sized gravels.

Cutthroat (*O. clarki*)
The cutthroat, like the coho, is a highly ubiquitous species. These fish can be found in most western Washington lakes, rivers and streams. Like the steelhead, the cutthroat has both the anadromous and non-anadromous forms. In the anadromous form the cutthroat spends from 2-4 years in freshwater prior to smoltification (Fuss 1982), and usually spends a year or less in the marine environment before returning to spawn. The anadromous cutthroat spawns in mid-winter through early spring, while the non-anadromous variety spawns in spring. The cutthroat usually seeks out small, remote headwater tributaries for spawning and early rearing, where it can minimize competition with other salmon species (Glova 1978). Small-sized gravels with some sand are most often used for spawning. As the rearing juveniles grow older they move downstream into larger streams where they mingle with other salmon species. The rearing habitats of preference are the riffles for the very young and deep pools with LWD for older year classes. During the winter, older aged cutthroat often move into pond fed and other runoff tributaries for refuge from high flows, and for preferred feeding conditions (Cederholm and Scarlett 1982). Many of the very steep headwater tributaries are occupied by non-anadromous forms of cutthroat (Lestelle 1978; Osborn 1981). Lake dwelling cutthroat can grow to very large size and are most often non-anadromous (Wydoski and Whitney 1979).

Pacific Salmon Status and Distribution
In western North America, anadromous salmonids range from mid-California to the Arctic Ocean (Meehan and Bjornn 1991). Their historic distribution included southern California and Mexico (Wilderness Society 1993). Freshwater salmonid habitat extends eastward into Idaho, i.e., the Snake River and its tributaries. All species from the Pacific Northwest migrate out into the Pacific Ocean, some traveling as far north as the Bering Sea. Anadromous salmonids occupy all of Washington except the area north of the Snake River drainage and east of the Columbia River in central Washington and the area east of the Okanogan Highlands in northeastern Washington (WDF et al. 1993).

Stocks and Evolutionarily Significant Units. Fisheries management of salmon is normally done according to stocks. A stock is a discrete breeding population. The Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993 p. 10) has defined stock to be:

> The fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.

The spatial or temporal reproductive isolation required by this definition is reflected in the names given to stocks, e.g., "Nisqually River summer steelhead" or "Snohomish River fall chinook." Stocks may possess distinct biological characteristics (e.g., physical appearance, habitat preferences, genetics, or population demography), but not necessarily. As noted by Meehan and Bjornn (1991), "stock" can be considered synonymous with "subspecies."

The Endangered Species Act defines species as "any distinct population-segment of any species of vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. § 1531 et seq.). For purposes of the Endangered Species Act, salmon stocks are grouped into populations known as Evolutionarily Significant Units (ESU). If conditions warrant federal listing of a salmon, it is the stated intention of National Marine Fisheries Service to list ESUs, rather than an entire salmon species or individual stocks (56 Fed. Reg. 58612-8 (1991)). (Bull trout have not been separated into ESUs.)

An ESU is a population that (1) is substantially reproductively isolated from other population units of the same species; and, (2) represents an important component in the evolutionary legacy of the species (Waples 1991). The first criterion is essentially the same as the Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993) definition of a stock. The second criterion requires that sub-populations in separate ESUs possess significant genetic or other biological differences. As a result, many stocks are lumped into a single ESU. For example, agencies in Washington, Oregon, and California have identified more than 200 distinct stocks of coho salmon. These stocks have been grouped into six ESUs. Washington contains at least 90 stocks of coho (WDF et al. 1993), and these are distributed among three ESUs.

Salmonid Status in the Pacific Northwest. Nehlsen et al. (1991) assessed extinction risks for 214 native naturally spawning salmonid stocks occurring in Idaho, Washington, Oregon, and northern California. They defined three risk categories: high risk of extinction, moderate risk of extinction, and special concern. Stocks with a high or moderate risk of extinction have likely attained the threshold for listing under the Endangered Species Act. Stocks with a moderate risk have a larger number of spawning adults each year than do stocks with a high risk. Stocks of special concern have not attained the threshold for listing, but do face some risk of extinction or possess some unique characteristic that requires attention. Nehlsen et al. (1991) estimated that 101 (47 percent) of stocks in the Pacific Northwest had a high risk of extinction, 58 (27 percent) had a moderate risk, and 54 (25 percent) were of special concern.

Under the Endangered Species Act, the National Marine Fisheries Service regulates salmon, and it has declared several different salmonid populations as threatened or endangered. The agency listed Sacramento River winter chinook as threatened in 1990 (Nehlsen et al. 1991) and Snake River sockeye as endangered in 1991 (56 Fed. Reg. 58619-24 (1991)). Spring/summer and fall runs of Snake River chinook were listed as threatened in 1992 (47 Fed. Reg. 14653-5 (1992)). In March 1995, the steelhead populations in the Klamath Mountain of northern California were proposed for listing as threatened (60 Fed. Reg. 14253-61 (1995)).

The National Marine Fisheries Service initiated status reviews for west coast steelhead trout in May 1993 and coho salmon in October 1993 (58 Fed. Reg. 57770-1 (1993); 59 Fed. Reg. 27527-8 (1993)). The status review for steelhead is expected to be completed in 1996. The status review for coho, completed in July 1995, proposed that the species be federally listed in Oregon and California, but not in Washington (60 Fed. Reg. 38011-30 (1995)).

The federal government initiated coastwide status reviews for the other five anadromous salmonids in September 1994 (59 Fed. Reg. 46808-10 (1994)). The first of these reviews, for pink salmon, was to be completed in 1995. Completion of the status reviews for chum, sockeye, and chinook salmon, and sea-run cutthroat will probably occur in 1996. The federal listing of salmonid species could be followed by federal regulations pertaining to forest practices on nonfederal lands.

Salmonid Status in Washington. The Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993) identified 435 distinct salmonid stocks in Washington. Information for 322 stocks was adequate to assess their status, and of these, 38 percent were classified as "depressed" and 4 percent as "critical" (WDF et al. 1993). A depressed stock is one "whose production is below expected levels based on available habitat" (WDF et al. 1993 p. 30), and a critical stock is one for which "permanent damage to the stock is likely or has already occurred" (WDF et al. 1993 p. 30).

Nehlsen et al. (1991) compiled a list of Pacific Northwest salmon stocks threatened with extinction. For stocks in Washington, their list describes 47 as having a high risk of extinction, 18 as having moderate risk, and 27 as being of special concern. A partial list of extinct stocks (Nehlsen et al. 1991) includes 42 stocks from Washington.

Salmonid Status in the Five West-side Planning Units. The riparian conservation strategies proposed under this HCP will be applied to only the HCP planning units west of the Cascade crest. Therefore, the discussion of stock status in the area covered by the HCP is confined to those planning units. There are 299 distinct salmonid stocks in these HCP planning units (WDF et al. 1993). The status of these stocks is summarized in Table 4.5.1. For those 227 stocks for which a status could be determined, 36 percent were depressed and 4 percent were critical (WDF et al. 1993). Nehlsen et al. (1991) rated 38 stocks as having a high risk of extinction and 12 as having a moderate risk.

Distribution on DNR-managed Lands in the Five West-side Planning Units. To determine the distribution of species of anadromous salmonids on DNR-managed lands covered by the HCP, we performed an analysis using the agency's computerized geographic information system with input from the Washington Department of Fish and Wildlife's Washington Rivers Information System, which identifies all streams that salmonids are known or expected to inhabit. Digital data are to the 1:100,000 scale, and the presence of fish species is recorded by river reach.

Using this database, all watershed administrative units (WAUs) that are known or thought to contain salmonids were tabulated. Over 80 percent of DNR-managed lands west of the Cascade crest in the area covered by the HCP are in WAUs that contain coho, chinook, and steelhead (Table 4.5.2). Smaller percentages of DNR-managed lands are in WAUs that contain the other four anadromous salmonids. With the exception of the South Puget Planning Unit, all west-side planning units have at least 80 percent of their DNR-managed lands within WAUs that contain a salmonid species.

WAUs range in size from 10,000-50,000 acres. Given the relatively small area of WAUs compared to HCP planning units, we assumed that in a WAU identified as containing a salmonid species that all Type 1, 2, and 3 Waters in that WAU are inhabited by that species. Using this assumption, the assessment shows that approximately 900 miles of Type 1, 2, and 3 Waters on DNR-managed forest land in the five west-side planning units potentially contain coho, steelhead, chinook, chum, and sea-run cutthroat (Table 4.5.3). On the basis of stream miles, the density and distribution of salmonids vary widely among species. For example, the DNR analysis estimates that coho salmon may occupy over 900 stream miles but sockeye are to be found in only 270 stream miles. All the Type 1, 2, and 3 stream miles on DNR-managed land in the South Coast Planning Unit contains at least one species of anadromous salmonid. At least 90 percent of Type 1, 2, and 3 streams on DNR-managed land in the Straits, North Puget, and Columbia planning units contain a species of anadromous salmonid. To estimate the potential impacts of forest practices activities on DNR-managed land, we assumed that (1) all managed land within a WAU affects salmonid habitat; and, (2) impacts by individual landowners are proportional to the amount of land they manage within a WAU. For some WAUs, these assumptions may be weak. For example, DNR may manage 10 percent of a WAU, but that 10 percent affects 90 percent of the salmonid spawning habitat in that WAU. Nevertheless, this analysis provides a useful estimate of DNR's potential impacts on salmonid populations. DNR staff calculated the total area of WAUs identified as containing salmonid species as well as the total area of DNR-managed land within these WAUs. The ratio of these two numbers is the proportion of DNR-managed land that could affect salmonids. This proportion suggests the magnitude of the potential impact that DNR forest management may have on these species. For example, in the Straits Planning Unit, on average, about 15 percent of all land that could impact chinook salmon is managed by DNR (Table 4.5.4). In the five west-side planning units, on average, about 11 percent of all land that could affect salmonids is managed by DNR.

Differences in impacts among individual planning units reflect differences in the distribution of DNR-managed lands relative to the species range. For example, pink salmon spawn in the lower reaches of coastal rivers (Emmett et al. 1991), and therefore, planning units with DNR-managed lands near the Pacific coast have a greater impact on this species. In the Straits Planning Unit, 13 percent of all land that could impact pink salmon is managed by DNR, but in the South Puget Planning Unit, only 2 percent is managed by DNR (Table 4.5.4).

Table 4.5.1: Status of salmonid stocks[1] within the west-side HCP planning units

	Status[2]				Extinction Risk[3]		
	Healthy	Depressed	Critical	Unknown	High	Moderate	Special Concern
Coho	26	31	1	9	7	0	0
Chinook	34	13	4	8	14	0	1
Chum	45	3	2	12	3	3	0
Sockeye	0	3	1	0	1	0	0
Pink	9	1	0	2	2	1	0
Steelhead	23	30	1	41	9	7	10
Sea-run Cutthroat[4]	--	--	--	--	2	1	8
Total stocks	137	81	9	72	38	12	19

[1]Bull trout and Dolly Varden were not included in the SASSI (WDF et al. 1993) or Nehlsen et al. studies

[2]WDF et al. 1993

[3]Nehlsen et al. 1991

[4]Species not included in WDF et al.(1993)

Table 4.5.2: Percent of DNR-managed forest land by HCP planning unit watershed analysis units that contain salmonids

Source: DNR GIS April 1995

Planning Unit	SPECIES							
	Coho	Chinook	Chum	Sockeye	Pink	Steelhead	Sea-run Cutthroat	Total DNR- managed acres
South Coast	100	97	91	3	1	97	96	238,700
Straits	98	93	93	18	67	90	98	111,700
North Puget	82	80	77	48	62	81	37	396,400
South Puget	73	73	63	9	18	71	52	145,500
Columbia	81	67	39	25	0	78	81	289,300
Total west-side planning area	86	80	70	26	29	83	67	1,181,600

Table 4.5.3: Estimated miles of salmonid-bearing streams (Types 1, 2, and 3) by salmonid species on DNR-managed lands in the five HCP planning units west of the Cascade crest (excluding the OESF)

Source: DNR GIS April 1995

Planning Unit	SPECIES							
	Coho	**Chinook**	**Chum**	**Sockeye**	**Pink**	**Steelhead**	**Sea-run Cutthroat**	**Total by Planning Unit**
South Coast	240	236	222	33	2	240	230	240
Straits	94	70	91	22	71	91	94	95
North Puget	258	239	245	138	198	258	84	284
South Puget	89	89	84	3	15	88	73	117
Columbia	236	208	144	76	0	227	230	263
Total by salmonid species	917	842	786	272	286	904	711	999

Table 4.5.4: Percent of total land area impacting salmonids that is managed by DNR in the five HCP planning units west of the Cascade crest (excluding the OESF). DNR-managed lands in the Columbia Planning Unit have no pink salmon.

Source: DNR GIS April 1995

Planning Unit	SPECIES						
	Coho	**Chinook**	**Chum**	**Sockeye**	**Pink**	**Steelhead**	**Sea-run Cutthroat**
South Coast	13	15	15	4	5	13	13
Straits	15	15	15	11	13	15	15
North Puget	13	14	15	14	13	13	15
South Puget	5	5	5	1	2	5	6
Columbia	14	13	13	16	--	14	13
Total west-side planning area	12	12	12	10	10	12	13

Alternative A

Current management of the riparian ecosystem on managed lands is expected to provide some protection of suitable spawning and rearing habitats for the seven species of Pacific salmon. This protection is provided primarily by the establishment of protection of wetland management zones (WMZs) on nonforested wetlands, and riparian management zones on all identifiable Type 1 through 4 Waters and where necessary on Type 5 Waters according to DNR's Forest Resource Plan policies. Based on a survey of timber sales sold on DNR-managed land since 1992, no timber management activity has occurred in 77 percent of the riparian management zones established on Type 1 through 5 Waters. Riparian management zones on smaller headwater streams have averaged 55 feet on Type 4 Waters and 19 feet on Type 5 Waters, and this may not be sufficient to protect downstream water quality and habitat integrity for the various salmon species. Type 4 Waters represent 15 percent and Type 5 and 9[5] Waters represent 75 percent of the stream miles on DNR-managed lands. The average width of WMZs has been 86 feet, and this is probably sufficient to protect these areas as overwintering habitats for juvenile salmon, as well as maintaining their hydrologic regulation value. Riparian management zones on Type 1 and 2 Waters have averaged 196 feet, and 89 feet on Type 3 Waters. Type 1 and 2 Waters represent 4 percent and Type 3 Waters represent 7 percent of the stream miles on DNR-managed lands. These WMZs and riparian management zones, although not guaranteed, provide some protection of the spawning and rearing habitats of these fish species. In addition, protection will be provided through the identification of, and prohibition of timber harvest on, unstable slopes, and through protection of salmon spawning, rearing, and overwintering areas as identified by an analysis of watersheds during landscape planning (WFPB 1995b). Hydrologic maturity is only addressed as part of forest practices watershed analysis. Under Alternative A, consideration of hydrologically mature forest is not a specific requirement of timber sale layout, however, WAC 222-22-100 gives interim regulatory measures prior to watershed analysis in the significant rain-on-snow zone where local evidence indicates that material damage to public resources has occurred during peak flows. Because this rule only affects harvests in watersheds where material damage to public resources has already occurred, some sedimentation and channel destabilization could occur. This process is only completed for a small percentage of DNR-managed lands. Because of the lack of minimum riparian management zone widths on Type 4 Waters, lack of wind buffers, lack of a comprehensive road network management plan, inconsistent consideration of hydrologic maturity, and lack of protection of along some Type 4, 5, and 9 Waters, Alternative A will not adequately protect many of the salmon habitat components (i.e., gravels, clean cool well-oxygenated water, LWD, etc.).

Alternative B

Management of the riparian ecosystem under Alternative B is expected to provide adequate guaranteed protection of spawning and rearing habitats of the seven species of Pacific salmon. Specific benefits of this alternative that would provide some guaranteed protection of aquatic habitats considered important to these species include the establishment of WMZs and riparian management zones on all identifiable Type 1 through 4 Waters. Type 5 Waters are protected when necessary, and there will be a 10-

[5] Type 9 Waters are untyped waters.

year research program undertaken to further our understanding of what forestry activities can be conducted around these streams without negatively impacting downstream aquatic habitat conditions. Protection of aquatic habitat would be provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmon habitat. Riparian management zone widths would be one site-potential tree (approximately 150 feet) or 100 feet whichever is greater on all Type 1 through 3 Waters. Riparian management zones on Type 4 Waters would be 100 feet. In addition, wind buffers of 50-100 feet would be added to the windward side of Type 1 through 3 Waters where there is a moderate potential for windthrow. Wetland management zones, based on a sight potential tree height or 100 feet whichever is greater, would be established on wetlands greater than or equal to 1 acre in size. Wetland management zone widths would be 100 feet on wetlands between 0.25 and 1 acre in size. Minimal harvest would occur in WMZs. Additional protection of aquatic habitats includes the protection of unstable slopes from mass-wasting events, and the protection of salmon spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WPFB 1995b). This protection is greater than that provided under Alternative A because of the minimum riparian management zone widths, wider management zones on wetlands and Type 3 and 4 Waters, guaranteed no-harvest restriction, and management that must maintain or restore salmon habitat. Alternative B uses the active channel margin to delineate the stream compared to Alternative A which uses the ordinary high water mark, and this will result in better protection of off-channel overwintering habitats for coho, steelhead, and cutthroat. Except for a few exceptions, two-thirds of DNR-managed lands in the significant rain-on-snow zone will be maintained in a hydrologically mature state. Alternative B would provide better protection from sediment runoff from roads than Alternative A, because of the minimization of active road density based on the comprehensive road network management plan. Because of all these protective measures Alternative B will more than adequately protect the salmon habitat components (i.e., gravels, clean cool well-oxygenated water, LWD, etc.).

ALTERNATIVE C

Management of the riparian ecosystem under Alternative C is expected to provide substantial guaranteed protection of spawning and rearing habitats of the seven species of pacific salmon. Specific benefits of this alternative that would provide substantial guaranteed protection of aquatic habitats considered important to these species include the establishment of WMZs and riparian management zones on all identifiable Type 1 through 5 Waters. Protection of the riparian management zone for aquatic species is provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to restore or enhance the quality of salmon habitat. Riparian management zone widths would be one site-potential tree (approximately 150 feet) or 100 feet whichever is greater on Type 1 through 5 Waters. In addition, wind buffers of 100 feet would be added to both sides of Type 1 and 2 Waters, and 50-foot wind buffers would be added to each side of Type 3 Waters greater than 5 feet wide. Wetland management zones, based on a sight potential tree height or 100 feet whichever is greater, would be established on wetlands greater than or equal to 1 acre in size. WMZs would be 100 feet on wetlands between 0.25 and 1 acre in size. Minimal harvest would occur in WMZs.

All bogs greater than or equal to 0.1 acre in size would receive WMZs. No harvest would occur in WMZs of forested wetlands. Except for a few exceptions, two-thirds of DNR-managed lands in the significant rain-on-snow zone will be maintained in a hydrologically mature state. Additional protection of aquatic habitats includes the protection of unstable slopes from mass-wasting events, and the protection of salmon spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). This protection is substantially greater than that provided under Alternative A because of the minimum riparian management zone widths, wider riparian management zones on wetlands and Type 3 through 5 Waters, additional wind buffers, guaranteed no-harvest restriction, hydrologic maturity considerations, and management that must restore or enhance salmon habitat. Alternative C would provide better protection from sediment runoff from roads than Alternative A, because of the minimization of active road density based on the comprehensive road network management plan. Because of all these protective measures Alternative C will more than adequately protect the salmon habitat components (i.e., gravels, clean cool well-oxygenated water, LWD, etc.).

Amphibians And Reptiles

One species of amphibian, the spotted frog, is a federal candidate for listing. Six species of amphibians and two species of reptiles that occur in the HCP planning area are either species of concern to the U.S. Fish and Wildlife Service or state candidates for listing as threatened or endangered (WDW 1993a; 61 Fed. Reg. 7457 (1996); USFWS 1996). The habitat requirements of, and assessments of the effects of the alternatives on, each of these species are presented in the following sections.

Larch Mountain Salamander (*Plethodon larselli*)

The Larch Mountain salamander has a highly restricted range (Herrington and Larsen 1985), and, until recently, was found only along a 36-mile stretch of the Columbia River Gorge in Washington and Oregon. However, four populations have been found near Mt. St. Helens and just south of Mt. Rainier (Leonard et al. 1993). Within its range, the Larch Mountain salamander occurs at elevations between 165 and 4,100 feet above sea level (WDW 1993b) and appears to have relatively restricted habitat requirements, including stabilized talus ranging in size between 0.4 and 2.3 inches with some soil deposits in the interstices, and at entrances to some caves (L. Jones, USFS, Olympia, WA, pers. comm., 1995). The species life requisites also appear to be met in old-growth forest stand conditions where woody debris may provide the protective refugia that are offered by talus in other areas (C. Crisafulli, USFS, Amboy, WA, pers. commun., 1995). Larch Mountain salamanders are more common in areas with dense overstories of conifers or deciduous trees that help maintain higher moisture levels (WDW 1993b). The species appears to be confined to talus, old-growth coniferous forests, or collapsed lava tubes throughout its range. The core of the species range is in DNR's Columbia and Klickitat planning units.

ALTERNATIVE A

Under this alternative, some talus slopes and large woody debris in older forests may be encompassed and protected within the riparian management zones or WMZs, and incidental to protection of owl habitat. Although no specific conservation measures are directed to potential Larch Mountain salamander habitat, such as talus fields or cave entrances, DNR voluntarily protects some talus in the range of the Larch Mountain salamander because the status of this species in Washington is listed as state sensitive.

ALTERNATIVE B

Some talus slopes in older forests may be encompassed and protected within the proposed riparian management zones, which overall would be wider than the riparian management zones under the No Action alternative, and are guaranteed. Under this alternative, forested and nonforested wetlands would be protected with buffers at least 100 feet in width, which may protect some large woody debris and, when adjacent to talus fields, would provide some protection of Larch Mountain salamander habitat. However, management activities are allowed in these buffers which may decrease the beneficial effects the buffers would have in maintaining critical temperature and moisture regimes required by the Larch Mountain salamander. Owl NRF habitat maintained or developed in the Klickitat and Columbia planning units, containing the known range of the Larch Mountain salamander, could contribute to maintenance of the integrity of talus fields and protect large woody debris within these NRF areas. Under Alternative B, the conservation objectives for talus fields greater than or equal to 1 acre in size, or greater than or equal to 0.25 acre in size in most of the Columbia Planning Unit, are to maintain its physical integrity and minimize dramatic changes in microclimate. Talus fields would be protected by a no-harvest restriction and, where practicable, road construction and extraction of road building materials would be avoided. In addition, a 100-foot wide forested buffer would be maintained around these talus fields. Harvest would be permitted in the buffer but only where 60 percent canopy cover could be retained, which is anticipated to adequately maintain the microclimate regimes within the buffered talus. In the forested talus outside of the buffer, no more than 33 percent of the volume would be harvested. These measures would adequately protect the integrity of the talus fields where Larch Mountain salamanders are known to occur. Under this alternative, cave entrances would be protected by a 250-foot no-harvest buffer which would maintain the microclimate near entrances, where these salamanders are known to occur, and by keeping cave locations confidential. This protection is substantially greater than Alternative A because of the specific conservation measures directed to special habitat types known to be used by Larch Mountain salamanders.

ALTERNATIVE C

Some talus slopes in older forests may be encompassed and protected within the proposed riparian management zones, which overall would be substantially wider than the riparian management zones under the No Action alternative, and are guaranteed. Under this alternative, forested and nonforested wetlands would have the same buffers as Alternative B, which may protect some large woody debris and, when adjacent to talus fields, would provide more protection of Larch Mountain salamander habitat. Owl NRF habitat maintained or developed in the Klickitat and Columbia planning units, would be greater than Alternative B and, thus, Alternative A, with the same benefits. The protection provided for uncommon habitat types in Alternative C is the same as in Alternative B. Therefore, protection of Larch Mountain salamander habitat under this alternative would be slightly greater than Alternative B because of the additional riparian protection that may include some additional talus fields, and substantially better than under the No Action alternative.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The Larch Mountain salamander is not known to occur in the OESF. Thus, an assessment of the OESF No Action and action alternatives is unnecessary.

Dunn's Salamander (*Plethodon dunni*), Van Dyke's Salamander (*Plethodon vandykei*), and the Tailed Frog (*Ascaphus truei*)

Dunn's and Van Dyke's salamanders are candidates for listing by the state (WDFW 1995b). The tailed frog (*Ascaphus truei*) is currently a species of concern to the U.S. Fish and Wildlife Service and a state monitored species (WDW 1993a; 61 Fed. Reg. 7457 (1996); USFWS 1996) These species utilize similar habitats for breeding, foraging, and resting. Thus, for purposes of this assessment, the effects of the alternatives on these species have been combined.

Dunn's Salamander

Dunn's salamander is found in southwestern Washington, western Oregon, and the extreme northwestern corner of California. In Washington, the species is found only in the Willapa Hills (Leonard et al. 1993). Dunn's salamanders are usually associated with seepages or streams located in heavily shaded areas (Rodrick and Milner 1991). They are considered to be a highly aquatic species of woodland salamander (Leonard et al. 1993). The species is located in the splash zone of creeks typically under rocks and occasionally under woody debris (Leonard et al. 1993). It has also been found in talus where there is high humidity (Leonard et al. 1993). The principal management recommendation of Rodrick and Milner (1991) is the maintenance of riparian corridors along all stream types, but especially Type 4 and 5 Waters. Additional recommendations exist for wet talus where the species is known to occur.

Van Dyke's Salamander

Van Dyke's salamander is endemic to Washington (Leonard et al. 1993). Approximately half of its known geographical distribution occurs on the Olympic Peninsula. It is considered at risk due to its limited distribution and the isolation of its disjunct populations. Van Dyke's salamanders are usually associated with seepages or streams located in mature and old-growth coniferous forests (Rodrick and Milner 1991). They are considered to be the most aquatic species of woodland salamanders (Leonard et al. 1993). The species is typically located in the splash zone of creeks under rocks, logs, and woody debris (Leonard et al. 1993). It has also been found in wet talus, forest litter, and lava tubes (Rodrick and Milner 1991). The principal management recommendation of Rodrick and Milner (1991) is the maintenance of riparian corridors along all stream types, but especially Type 4 and 5 Waters. Additional recommendations exist for wet talus where the species is known to occur.

Tailed Frog

Tailed frogs are found throughout the west-side HCP planning units including specimens collected from several sites on the Olympic Peninsula (Nussbaum et al. 1983). Tailed frogs occur in or near fast-flowing, permanent streams within forested areas. The species prefers cold temperature waters and has a narrow range of temperature tolerance. Adults forage along stream edges or from the surface of exposed rocks or downed logs, and during wet nights in the adjacent forest (Nussbaum et al. 1983). Tailed frogs are the only genus of anurans in North America that is adapted for life in cold fast-flowing mountain streams (Nussbaum et al. 1983). The species shows a preference for older forests. Welsh (1990) found that at low elevation sites (less than 3,280 feet) tailed frog density was correlated with forest age, and Carey (1989) found that tailed frogs were closely associated with old-growth forests.

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide some protection of suitable habitat for the Dunn's and Van Dyke's salamanders, and the tailed frog. This protection would be provided primarily by the establishment of wetland buffers, and riparian management zones on all identifiable Type 1 through 5 Waters. Since 1992, no timber management activity has occurred in 77 percent of the riparian management zones established on Type 1 through 5 Waters. Riparian management zones on smaller headwater streams used by these three species have averaged 52 feet on Type 4 Waters, and 40 feet on Type 5 Waters that have received protection; 53 percent of Type 5 Waters have received no riparian management zones. On the Olympic Peninsula, no-harvest riparian management zones on Type 4 and 5 Waters have averaged 96 and 105 feet, respectively. These riparian management zones, although not guaranteed, provide some protection of the breeding, foraging and resting habitat of these amphibian species. In addition, protection is provided through the identification of, and prohibition of timber harvest on, unstable slopes, and through protection of salmonid spawning, rearing, and overwintering areas identified by an analysis of watersheds during landscape planning (WFPB 1995b). Alternative A contains no provisions for protection of talus which likely results in negative impacts to Dunn's and Van Dyke's salamanders, when wet talus areas incur some harvest.

ALTERNATIVE B

The riparian conservation strategy under Alternative B should adequately protect the breeding, foraging, and resting habitats of Dunn's and Van Dyke's salamanders and the tailed frog. Riparian buffers would be established as described in DEIS Chapter 2 and draft HCP Chapter IV. This protection includes 100-foot buffers on Type 4 streams where these species are known to occur. Based on current No Action activities and the protection of steep and unstable slopes of this alternative, it is anticipated that greater than 50 percent of Type 5 streams will be protected by restrictions on management activities near these streams. Riparian buffers would include a 25-foot no-harvest zone likely protecting stream splash zones occupied by Dunn's and Van Dyke's salamander. Management activities within the riparian buffers would be stratified according to the constraints imposed by the no-harvest, minimal-harvest, and low-harvest areas. Under the management anticipated to occur in the no-harvest and minimal-harvest areas, forests with mature or old-growth characteristics are expected to develop. The riparian buffer is thought to be sufficient for maintaining the key components of salmonid habitat: stream bank integrity, stream shading, sediment load, detrital nutrient load, and large woody debris, and thus the habitat of many amphibians such as Van Dyke's salamander and the tailed frog. Under Alternative B, the ecological integrity of the riparian buffers would be protected by an additional wind buffer on Type 1, 2, and 3 Waters on the windward side of the stream where there is a moderate potential for windthrow. Additional protection of aquatic habitat would occur through road network management that minimizes adverse impacts to salmonid habitat. The Dunn's and Van Dyke's salamanders are occasionally found in talus (Rodrick and Milner 1991). Talus fields that are greater than or equal to 1 acre in size throughout the HCP area, and greater than or equal to 0.25 acre in the Columbia Planning Unit, would be protected as described in draft HCP Chapter IV, Section F and Appendix 3, Chapter IV, Section F, in this document. Van Dyke's salamander may be found in seeps within old-growth forests. Some of this habitat would be protected as a result of the designated owl NRF areas on DNR-managed lands, the WMZs around forested wetlands, and riparian management zones in unstable slope areas. The protection provided under Alternative B would be greater than under the No Action alternative because of the larger riparian and wetland buffers that are guaranteed, the no-harvest provision of the buffers, and the talus field protection.

ALTERNATIVE C

The riparian conservation strategy under Alternative C should adequately protect the breeding, foraging, and resting habitats of Dunn's and Van Dyke's salamanders and the tailed frog. Riparian buffers would be established as described in DEIS Chapter 2, which would be greater than those under Alternative B. This would increase the likelihood that some of the habitat upon which these species rely would be protected. Wetlands and talus field protection would be the same as under Alternative B, thus providing the same benefits as described above. The protection provided under Alternative C would be substantially greater than under the No Action alternative because of the larger riparian and wetland buffers that are guaranteed, especially on Type 4 and 5 Waters, the additional wind buffers, the no-harvest provision of the riparian management zone and WMZ buffers, and the talus field protection.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF would provide at least some protection of breeding, foraging, and resting habitat of Van Dyke's salamander and the tailed frog. The Olympic Region of DNR currently places mass-wasting buffers along streams that in the recent past have averaged 96 and 105 feet for Type 4 and 5 Waters, respectively. No timber removal or timber management activity occurs within these buffers or in areas identified as unstable. An additional layer of protection for habitat required by these species is assured through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Alternative 1 contains no provisions for protection of talus which likely would result in negative impacts to Dunn's and Van Dyke's salamanders, when wet talus areas incur some harvest.

OESF ACTION ALTERNATIVES

Management of the riparian ecosystem on the OESF would be the same under both action alternatives, which is similar to Alternative C. This strategy would be expected to provide substantial protection of breeding, foraging, and resting habitat of Van Dyke's salamander and the tailed frog. Ecosystem protection under these alternatives are intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which would be expected to benefit other aquatic species. The protection measures for talus fields described under Alternatives B and C above would also be implemented under both action alternatives on the OESF. Thus, the OESF action alternatives would likely provide greater conservation benefits to these amphibians than the OESF No Action alternative.

Northern Red-legged Frog (*Rana aurora aurora*), **Cascades Frog** (*Rana cascadae*), **and Spotted Frog** (*Rana pretiosa*)

The northern red-legged frog, Cascades frog, and the spotted frog are known to breed in nonforested wetlands and to forage and rest in these habitats as well as in other riparian areas in forested ecosystems. Thus, for the purposes of this assessment, breeding, foraging, and resting habitats are considered to include both wetlands and riparian areas in forested ecosystems. Since their habitats are similar, discussions of the effects of the alternatives on these species have been combined.

Northern Red-legged Frog

Red-legged frogs inhabit moist and riparian forests, usually below 2,790 feet in elevation in the Pacific Northwest (Nussbaum et al. 1983; Stebbins 1985). This species is generally found near permanent water, including small ponds, quiet pools along streams, reservoirs, springs, lakes and marshes (Gordon 1939; Stebbins 1954, 1985; Nussbaum et al. 1983). Although Stebbins (1954) describes red-legged frogs as being "highly aquatic," individuals may be found in forests at considerable distances from water (Gordon 1939; Stebbins 1954; Nussbaum et al. 1983). Breeding habitats for this species vary greatly; red-legged frogs may breed in small temporary ponds, relatively large lakes, in potholes, in overflows of lakes and rivers, or in slow-moving portions of rivers (Storm 1960; Licht 1969, 1971; Calef 1973; Brown 1975; Nussbaum et al. 1983). Foraging and resting habitats occur in the same habitats as breeding, as well as in wet meadows, seeps, and hardwood shrub wetlands (Brown 1985). Although not restricted to old-growth habitat, the red-legged frog is frequently found in old-growth stands (Bury and Corn 1988). In southern Washington, Aubry and Hall (1991) found that this species was most abundant in mature stands and least abundant in young stands.

Cascades Frog

This frog is a montane species found in the Olympic Mountains of Washington, and in the Cascade mountains of Oregon, Washington and northern California (Nussbaum et al. 1983). The extent of the Cascades frog's distribution in the OESF Planning Unit is uncertain. Cascades frogs generally occur above 2,625 feet in elevation in montane meadows. This species is generally found in relatively small bodies of water rather than in large lakes (Sype 1975; O'Hara 1981; Nussbaum et al. 1983). Frequently used habitats include relatively small, unvegetated potholes and marsh-like areas that are overflows of larger lakes (O'Hara 1981). Occasionally, Cascades frogs are found in forests away from water (Nussbaum et al. 1983). Breeding habitat for Cascades frogs in the central Cascade mountains of Oregon include shallow, gently sloping margins of the shore or overflow areas, generally over soft substrates and protected from severe wave action (O'Hara 1981). In the larger ponds in which they are found, Cascades frog tadpoles prefer relatively warm, shallow water close to the shoreline with abundant vegetation (O'Hara 1981). Foraging and resting habitat occurs in the above described riparian/wetland habitats of high-elevation coniferous and subalpine forests (Brown 1985).

Spotted Frog

Although historically occurring throughout the western Cascades and Puget Sound trough, current populations of spotted frogs are extremely rare west of the Cascade mountains in Washington (McAllister and Leonard 1990). Spotted frogs are highly aquatic, using marshy ponds, streams, and lakes as high as 9,842 feet in parts of their range (Stebbins 1954, 1985; Nussbaum et al. 1983). Spotted frogs are found in numerous habitat types, including those dominated by Douglas-fir and ponderosa pine, and semi-arid to arid sites dominated by sagebrush (Stebbins 1954, 1985). Stebbins (1985) suggests that this species is more common in relatively cold water habitats than in warm, stagnant ponds. In Washington, WDFW (1994a) reports that courtship and breeding habitat includes warm, shallow margins of ponds or rivers, or in temporary ponds. Foraging and resting habitats include the same habitats as breeding, as well as early seral stages of coniferous forests along riparian/wetland habitats (Brown 1985).

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide at least some protection of suitable breeding, foraging, and resting habitats for the northern red-legged frog, Cascades frog, and spotted frog. Because breeding, foraging, and resting habitats for each of these frog species includes palustrine wetlands such as small ponds, bogs and forested swamps (i.e., vegetated and non-vegetated wetlands), and to some extent Type 2 and 3 Waters, the primary source of protection provided under the No Action alternative is through the establishment of, and restriction of timber management activities within, WMZs and riparian management zones on all identifiable Type 1 through 5 Waters. The average width of WMZs on nonforested wetlands, established according to DNR's FRP policies, has averaged 86 feet in the recent past. Riparian management zones on Type 2 Waters have averaged 196 feet, while riparian management zones on Type 3 Waters have averaged 89 feet. Although in recent years no timber harvest activities have occurred in 77 percent of the riparian management zones established on Type 1 through 5 Waters, some of these Waters have received no riparian management zone. Additional protection of the habitats for these species would also be provided through the prohibition of timber harvest on unstable slopes, and through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Impacts to these species under Alternative A would likely be as a result of management activity in the riparian management zones and WMZs, and, specifically for the red-legged frog, timber removal in mature stands.

ALTERNATIVE B

Management of the riparian ecosystem under Alternative B is expected to provide adequate protection of the breeding, foraging, and resting habitats for the northern red-legged frog, Cascades frog, and spotted frog. Specific benefits of this alternative include the establishment of riparian management zones on Type 1 through 4 Waters as described in DEIS Chapter 2 and draft HCP Chapter IV. The prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmonid habitat, and thus, habitat likely to be inhabited by the red-legged frog. Riparian buffers combined with wind buffers on the windward side where there is a moderate potential for windthrow would increase riparian protection. This protection would contribute to the maintenance of the integrity of slow-moving streams, backwater eddies, and adjacent forest stands in which these species occur. Wetland buffers would be at least 100 feet on wetlands greater than or equal to 0.25 acre in size with management restrictions that include some basal area maintenance, preclusion of ground-based equipment, and on-site mitigation for road building. This protection is greater than that provided under the No Action alternative because of the guaranteed no-harvest restriction, wider buffers on Type 3 and 4 Waters, wider wetlands buffers, and management that must maintain or restore salmonid habitat.

ALTERNATIVE C

Management of the riparian ecosystem under Alternative C is expected to provide substantial protection of the breeding, foraging, and resting habitats for the northern red-legged frog, Cascades frog, and spotted frog. Specific benefits of this alternative include the establishment of riparian management zones on Type 1 through 4 Waters as described in DEIS Chapter 2 and draft HCP Chapter IV. Additional wind buffers of 100 feet would be established on each side of Type 1 and 2 Waters. Each side of a Type 3 Water greater than 5 feet wide would have a 50-foot wind buffer. In addition to the wetlands protection provided under Alternative B, bogs greater than or equal to 0.1 acre would receive 100-foot buffers, and nonforested wetlands would have a 50-foot no-harvest zone. This protection is substantially greater than that provided under the No Action alternative because of the wider buffers on Type 3, 4, and 5 Waters, additional wind buffers, the wider wetlands buffers, guaranteed no-harvest restrictions in riparian management zones and WMZs, and management that must restore or enhance salmonid habitat.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF would provide at least some protection of breeding, foraging, and resting habitat of the northern red-legged frog and Cascades frog. The spotted frog is not found in the OESF. The Olympic Region of DNR currently places mass-wasting buffers along streams that in the recent past have averaged 96 and 105 feet for Type 4 and 5 Waters, respectively. No timber removal or timber management activity occurs within these buffers or in areas identified as unstable. Wetland management zones will be similar to the HCP No Action alternative, averaging approximately 86 feet. An additional layer of protection for habitat required by these species is assured through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b).

OESF ACTION ALTERNATIVES

Management of the riparian ecosystem on the OESF would be the same under all action alternatives, which is similar to Alternative C, and described in DEIS Chapter 2 and draft HCP Chapter IV. The strategy of providing, on average, 100-foot interior-core buffers on Type 3 and 4 Waters, and exterior buffers would be expected to provide substantial protection of breeding, foraging, and resting habitat of the northern red-legged frog and Cascades frog. Wetlands buffers on nonforested wetlands would prohibit harvest within 50 feet of the wetland's edge, which should contribute to the maintenance of the wetland integrity. Ecosystem protection under these alternatives are intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which would be expected to benefit other aquatic species. This protection is substantially greater than that provided under OESF Alternative 1 because of the wider buffers on Type 3, 4, and 5 Waters, additional wind buffers, the wider wetlands buffers, guaranteed no-harvest restrictions in riparian management zones and WMZs, and management for salmonid habitat.

Northwestern Pond Turtle (*Clemmys marmorata marmorata*)
Records in Washington indicate that the occurrences of the northwestern pond turtle appear to be clustered around the southeastern edge of Puget Sound and along a small portion of the Columbia River (Nussbaum et al. 1983; WDW 1993f). Populations are confirmed only in Klickitat and Skamania Counties, with recent individual sightings of northwestern pond turtles in Pierce, King, and Kitsap Counties (WDW 1993f). Historical records also exist in Clark and Thurston Counties (WDW 1993f). The northwestern pond turtle inhabits marshes, sloughs, moderately deep ponds, and slow-moving portions of creeks and rivers. Foraging habitat occurs in these same habitats (Brown 1985). Their resting habitat includes emergent basking sites, such as partially submerged logs, vegetation mats, rocks, and mud banks (Nussbaum et al. 1983; J. Beatty, Oregon State University, Corvallis, pers. commun., 1995). Pond turtles hibernate in the bottom mud of streams or ponds, or on land up to 1375 feet (500 meters) from water (Ernst and Barbour 1972; Holland 1989; Slavens 1992). The breeding habitat is most often located near the margin of a pond or stream, but pond turtles have been found hundreds of meters from water (Stebbins 1954; Nussbaum et al. 1983) and utilize meadows as well as young seral stages of most forest types including hardwoods, mixed hardwoods, and coniferous forests.

ALTERNATIVE A

Since the northwestern pond turtle is listed by the state as an endangered species, critical wildlife habitat has been designated for this species and is protected under each of the proposed alternatives by the Washington Forest Practices Rules (WFPB 1995c). As described in WAC 222-16-080, no "harvesting, road construction, aerial application of pesticides, or site preparation within 0.25 mile of a known individual occurrence, documented by the department of wildlife" is allowed. Thus, management under the No Action alternative is expected to provide substantial protection of known northwestern pond turtle breeding, foraging, and resting habitat. Protection of unknown turtle habitat, which would likely occur in riparian and wetland areas, would likely be provided under current DNR policy. Buffers on riparian management zones and WMZs (DEIS Chapter 2), when established, have been, on average, sufficient to maintain the integrity of riparian and wetland ecosystems. However, these buffers are not guaranteed, and the policy could change to provide less protection in the future.

HCP ALTERNATIVES

In addition to the protection provided by the Washington Forest Practices Rules, protection of essential northwestern pond turtle habitat where turtles have not been observed would be guaranteed through the protection of wetlands and riparian areas as described under each of the HCP alternatives. Protection of some potential pond turtle habitat would be provided by a 25-foot no-harvest area within each riparian management zone established, and the constraint on activities within the remainder of the zone to those that are expected to restore or enhance the quality of salmonid habitat. Thus, aquatic species such as the northwestern pond turtle would benefit from the conservation measures developed in these alternatives for the protection of salmonids. Wetland buffers would be at least 100 feet for wetlands greater than or equal to 0.25 acre in size. Alternative C would add a no-harvest zone within 50 feet of the wetland's edge, and bogs greater than or equal to 0.1 acre would be protected with a 100-foot buffer. Although these alternatives do not provide any additional specific protection of known occurrences of the northwestern pond turtle to that afforded under the No Action alternative, they provide greater protection of riparian and wetland zones. The wetlands buffers would be a source for providing greater amounts of LWD than under the No Action alternative, which would contribute loafing sites for turtles in and around the wetlands. This wetlands protection, unlike the No Action alternative, is guaranteed and would protect areas that may be inhabited by northwestern pond turtle yet to be discovered.

OESF Alternative 1 and Action Alternatives

The northwestern pond turtle is not expected to occur in the OESF. Thus, an assessment of the OESF No Action alternative and action alternatives is unnecessary.

California Mountain Kingsnake (*Lampropeltis zonata*)

The California mountain kingsnake specimens have been collected in Skamania and western Klickitat Counties from sites near the Columbia River Gorge (Nussbaum et al. 1983). California mountain kingsnakes occur in oak and pine forests and on chaparral up to 9,000 feet in elevation (Nussbaum et al. 1983). Their breeding, foraging, and resting habitat occurs primarily in early to mid-seral stage forests (Brown 1985). They may be found under and inside rotting logs and sometimes under rocks (Nussbaum et al. 1983).

Alternative A

At present, management activities in DNR-managed forests do not include harvest of oak woodlands. Where these woodlands provide habitat for the California mountain kingsnake, the habitat would be retained as a consequence of this policy. It is not guaranteed. Timber management activities are conducted in Douglas-fir/ponderosa pine forests characteristic of east-side owl habitat, which may contain habitat for the California mountain kingsnake. Since there are no specific provisions in the Washington Forest Practices Rules or DNR's FRP policies for protection of this species of snake, harvest activities in these east-side forests may impact this species. However, habitat may also develop as a result of normal timber management activities which create early to mid-seral-stage forests.

Alternative B

The riparian conservation strategy under this alternative would provide some guaranteed protection of the breeding, foraging, and resting habitat of the California mountain kingsnake. No harvest would occur on hillslopes with a high risk of mass wasting, and some oak forests would exist within or immediately below unstable areas. The riparian management zones along Type 1, 2, 3, and 4 Waters may also encompass some oak forest. This alternative has a special provision to protect Oregon white oak woodlands and some ponderosa pine stands where white oak is a significant component (draft HCP Chapter IV). Protection measures include retention of large dominant oaks and maintenance of 25-50 percent canopy cover in Oregon white oak woodlands. These forests occur in the Columbia Gorge, and the east slope of the southern Washington Cascades. Protecting these forests would also ensure that California mountain kingsnake habitat would be protected. This protection would be greater than that provided under Alternative A.

ALTERNATIVE C

The riparian conservation strategy under this alternative is expected to provide guaranteed protection of the breeding, foraging, and resting habitat of the California mountain kingsnake. No harvest would occur on hillslopes with a high risk of mass wasting, and some oak forests would exist within or immediately below unstable areas. The riparian management zones along Type 1, 2, 3, and 4 Waters may also encompass some oak forest. This alternative contains the same provision to protect Oregon white oak woodlands as Alternative B, and thus the same protection to the California mountain kingsnake, which would be greater than that provided under Alternative A.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The California mountain kingsnake is not expected to occur in the OESF. Thus, an assessment of the OESF No Action alternative and action alternatives is unnecessary.

Birds

Twenty priority species of birds may occur in the HCP planning area. Thirteen of these are species of concern to the U.S. Fish and Wildlife Service or state candidates for listing. One species, the Sandhill crane, is listed as endangered by the state. The band-tailed pigeon and five species of cavity-nesting ducks are considered game species by the state, however, there is concern for these species because of their need for special habitats such as mineral springs or suitable cavity trees/snags. The habitat requirements of, and assessment of the effects of the alternatives on, these species are presented below.

Common Loon (*Gavia immer*)

The common loon is known to breed at only a few locations in western Washington (Rodrick and Milner 1991), and it winters along the Pacific coast. Declines in common loon populations have been attributed to the loss of nesting habitat (Erhlich et al. 1988). Common loons breed on large wooded lakes with dense populations of fish (Rodrick and Milner 1991). Nests are built on the ground within 5 feet of the water's edge (Rodrick and Milner 1991). Nest sites may be reused in successive years.

ALTERNATIVE A

Current FRP policy for protection of forested and nonforested wetlands is directed at maintaining "no net loss of acreage or function." Management activities in the recent past have resulted in WMZs averaging 86 feet in width on nonforested wetlands, which is adequate to protect loon nesting habitat at the water's edge. Although this protection is not guaranteed, it is anticipated this policy will continue. Protection for forested wetlands is limited to restricting ground disturbance, and leaving a minimum basal area in trees. The impacts of this management activity are unknown.

ALTERNATIVE B

The wetlands protection strategy, under Alternative B, is expected to protect the lake habitat utilized by the common loon. Buffers along the shoreline of nonforested wetlands greater than or equal to 0.25 acre in size would be at least 100 feet wide (DEIS Chapter 2 and draft HCP Chapter IV) would be sufficient to protect potential loon nesting habitat. The adverse impacts of human disturbance could possibly be minimized by the blocking effect of the wetland buffers. In addition, to reduce the adverse effects of human disturbance, DNR would not allow activities within 500 feet of a known active nest that would appreciably reduce the likelihood of nesting success between April 1 and September 1. This protection is greater than the No Action alternative because of the wider guaranteed wetland buffers, and the seasonal nest site protection.

ALTERNATIVE C

Under Alternative C, wetland buffers would receive the same protection as described in Alternative B (DEIS Chapter 2, draft HCP Chapter IV) with an additional provision prohibiting harvest within 50 feet of the wetland's edge. The same seasonal nest site protection as that provided in Alternative B would also be implemented. This protection is greater than the No Action alternative because of the wider guaranteed wetland buffers, the no-harvest area, and the seasonal nest site protection.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The common loon is not known to breed in the OESF. Thus, an assessment of the OESF No Action and action alternatives was not conducted.

Harlequin Duck (*Histrionicus histrionicus*)

Harlequin ducks breed almost exclusively along fast-flowing mountain streams throughout the Cascade, Olympic, and Selkirk mountains in Washington (Bellrose 1976; Brown 1985; WDFW 1994a; Harlequin Duck Working Group 1993). Nests are typically located close to clear streams with rocky substrates and rapids (Harlequin Duck Working Group 1993). Nests may be on the ground in dense vegetation, piles of woody debris, undercut stream banks, between rocks, or in hollow trees (Harlequin Duck Working Group 1993). Bank vegetation near nest sites is highly variable, but the species is thought to show a preference for mature or old-growth forest in the Pacific Northwest (Harlequin Duck Working Group 1993; Rodrick and Milner 1991). Foraging habitat for the harlequin duck includes fast-moving streams where they feed primarily on benthic macroinvertebrates and roe (Harlequin Duck Working Group 1993). Resting habitat is generally described as mid-stream loafing sites (Rodrick and Milner 1991) such as gravel bars or large woody debris. Wintering habitat typically includes saltwater habitats within 140 feet (50 meters) of the shore and most of the Puget Sound (Gaines and Fitzner 1987; Wahl and Paulson 1991; WDFW 1994a). Human disturbance greatly affects this species, therefore, WDFW (1994a) recommends that roads and trails should be located farther than 165 feet from streams used by harlequin ducks.

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands according to DNR's FRP policies is expected to provide at least some protection of breeding, foraging and resting habitats for the harlequin duck. This protection would be provided primarily by the establishment and protection of riparian management zones on all identifiable

Type 1 through 5 Waters, within which no management activity has occurred in 77 percent of the riparian management zones in the recent past. Buffers along Type 1 and 2 Waters have averaged 196 feet, and buffers on Type 3 Waters have averaged 89 feet. The riparian management zones of these widths would likely function as a source of in-stream large woody debris for loafing, as well as protect potential nest sites for harlequin ducks, and would be expected to continue. However, this level of riparian protection is not guaranteed. Additional protection is provided through the identification of, and restriction of timber harvest on, unstable slopes, and through protection of salmonid spawning, rearing, and overwintering areas as identified by an analysis of watersheds during landscape planning (WFPB 1995b). No specific provisions are currently being implemented to protect known nest sites from human disturbance.

ALTERNATIVE B

The management designed for protection of the riparian ecosystem under Alternative B would provide adequate protection of the breeding, foraging and resting habitats for the harlequin duck on DNR-managed lands. Specific benefits of this alternative considered important to this species include the establishment and protection of riparian management zones on all identifiable Type 1 through 4 Waters (draft HCP Chapter IV). Additional protection for this species is provided by the prohibition of harvest within a 25-foot no-harvest area within each riparian management zone established and the constraint on activities within the remainder of the zone to those that are expected to maintain and restore the quality of salmonid habitat, which may contribute to nest protection. The ecological integrity of the riparian buffer, and the duck habitat contained therein, would be protected by wind buffers along some streams where there is at least a moderate potential for windthrow as described in draft HCP Chapter IV. Aquatic habitats would also be maintained by the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). The adverse impacts of human disturbance would be minimized by the riparian buffer which is estimated to have an average width of 150 to 160 feet. Human disturbance would be further reduced by the wind buffer which would be placed along many reaches of Type 1, 2, and 3 Waters. DNR would not allow any activities within 165 feet of a known active harlequin duck nest, between May 1 and September 1, that may cause an appreciable reduction in the likelihood of nesting success. However, no provisions are made to restrict trail construction which could potentially affect unknown nesting harlequin ducks. These protection measures are greater than that provided under the No Action alternative because the riparian management zones are guaranteed, the zones are wider than the current condition and include a no-harvest provision, and some effort would be made to minimize human disturbance to known active nests.

ALTERNATIVE C

The management designed for protection of the riparian ecosystem under Alternative C would provide substantial protection of the breeding, foraging and resting habitats for the harlequin duck on DNR-managed lands. Specific benefits of this alternative that would provide guaranteed protection of aquatic habitats include the establishment and protection of riparian management zones on all identifiable Type 1 through 5 Waters (DEIS Chapter 2). Additional protection for this species is provided by the prohibition of harvest within a 25-foot no-harvest area within each riparian management zone established, and the constraint on activities within the remainder of the zones to those that are expected to restore or enhance the quality of salmonid habitat. The ecological integrity of the riparian buffer, and the duck habitat contained therein, would be protected by additional 100-foot wind buffers on each side of Type 1 and 2 Waters and 50-foot wind buffers on Type 3 Waters. Aquatic habitats would also be maintained by the protection of unstable slopes from mass-wasting events, and the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). These provisions would ensure a continuous source of LWD, and potential nest sites. The adverse impacts of human disturbance would be minimized as described in Alternative B above. Human disturbance would be further reduced by the wind buffers along many reaches of Type 1, 2, and 3 Waters. However, no provisions are made to restrict trail construction which could potentially affect unknown nesting harlequin ducks. These protection measures are greater than that provided under the No Action alternative because the riparian management zones are guaranteed, the zones are wider than the current condition and include a no-harvest provision, and some effort would be made to minimize human disturbance to known active nests.

OESF Alternative 1

Current management of the riparian ecosystem on the OESF would provide at least some protection of breeding, foraging, and resting habitat of the harlequin duck. The Olympic Region of DNR currently places mass-wasting buffers along streams that in the recent past have averaged approximately 145 and 135 feet for Type 1 and 2 Waters, respectively. Buffers on Type 3 and 4 Waters will be about 95 feet in width. No timber removal or timber management activity occurs within these buffers or in areas identified as unstable. An additional layer of protection for habitat required by this species is assured through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b).

OESF Action Alternatives

Management of the riparian ecosystem on the OESF would be the same under all action alternatives. Specific protection of habitat required by this species would occur primarily from the establishment of, and restriction of timber harvest activities in, mass-wasting buffers (including unstable slope areas) along all identifiable streams, and through the protection of salmonid spawning, rearing, and overwintering areas as identified through an analysis of watersheds during landscape planning (WFPB 1995b). Riparian management zones on Type 1 and 2 Waters would average 300 feet; Type 3 Waters would average 250 feet (DEIS Chapter 2, draft HCP Chapter IV). This strategy would be expected to provide substantial protection of breeding, foraging, and resting habitat of the harlequin duck. Ecosystem protection under these alternatives are intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which would be expected to benefit other aquatic species. However, the nest protection provision described in Alternatives B and C above would not be implemented under either OESF action alternative because, presumably, the riparian protection would be adequate to protect harlequin duck nests. This protection is greater than the OESF No Action alternative because of the guaranteed wider riparian management zones, and restricted-harvest buffers.

Barrow's Goldeneye (*Bucephala islandica*), **Bufflehead** (*Bucephala albeola*), **Common Goldeneye** (*Bucephala clangula*), **Hooded Merganser** (*Lophodytes cucullatus*), **and Wood Duck** (*Aix sponsa*)

Cavity-nesting ducks are found throughout Washington and are considered game birds by the state. These ducks generally nest in large trees near low-gradient rivers, lakes, ponds, and sloughs (Rodrick and Milner 1991). Although hunted, these species are of concern because of their need for suitable cavity trees/snags near, generally within 200 meters (550 feet) of foraging and brooding habitat. Conservation efforts that provide substantial riparian and wetland buffers with sufficient cavity tree and snag compliments should benefit cavity-nesting ducks; these measures will also protect water quality in foraging and brooding habitats.

ALTERNATIVE A

Current management activities under Alternative A would provide no-harvest riparian buffers averaging 196 feet wide (range = 0-350 feet) on each side of Type 1 and 2 Waters, 89 feet wide (range = 0-300 feet) on Type 3 Waters, and 52 feet wide (range = 0-300 feet) on Type 4 Waters. These would likely provide suitable nesting habitat where forests, cavity trees, and snags are present. Regrowth of forests in portions of buffers where forests, snags, and cavity trees are lacking may also provide some support to cavity-nesting ducks, when trees reach a sufficient size and condition for primary excavators to create cavities. Forested wetland buffers will be harvestable, with a requirement to retain at least 120 square feet of basal area per acre in wind-firm trees, which may provide potential snags and cavity trees in the future.

Washington Forest Practices Rules requiring three wildlife reserve trees and two green recruitment trees may also provide potential cavity trees for use by cavity-nesting ducks when located near riparian and wetland buffers.

ALTERNATIVE B

Under this alternative, riparian management zones at least 100 feet wide would be established on Type 1 through 3 Waters, the inner-most portion of which would be a 25-foot wide no-harvest zone. Wind buffers 100 feet wide would be added to the windward side of Type 1 and 2 Waters; 50 feet wide on some Type 3 Waters (draft HCP Chapter IV). Forested wetlands would be at least 100 feet on wetlands greater than or equal to 0.25 acre. Implementation of this alternative could result in a reduction in habitat, in riparian areas adjacent to Type 1 through 3 Waters, from Alternative A because it provides smaller buffers that may be harvested. However, riparian buffers established under Alternative B would be guaranteed. Buffers established under Alternative A may be changed to something less in the future. Under this alternative, wetland buffers would be slightly larger than under Alternative A, but they would likely incur some management. Harvests in riparian and wetland buffers would probably reduce the number of suitable cavities for nesting, however the 25-foot no-harvest and minimal-harvest zones would ensure that some cavity trees near stream banks would be retained. Openings created by some harvest entries may, however, provide plant foods for species like the wood duck. Wind buffers, where designated, may provide additional area to buffers which could reduce disturbance and provide additional cavities for cavity-nesting ducks. The provision to retain three snags and five green trees per acre, as well as the provision to retain large, unique wildlife trees, would also provide potential cavity trees for use by cavity-nesting ducks when located near riparian buffers. Overall, Alternative B would be more beneficial in the long term than Alternative A because of the assurance of establishing no-harvest and minimal-harvest riparian and wetland buffers of a guaranteed width, and the provision to protect snags and provide green trees with the potential to become future cavity trees.

Alternative C

Under this alternative, riparian and wetland management zones would be similar to Alternative B, except that wind buffers would be added to each side of the Type 1 through 3 Waters, and wetland buffers would have a 50 foot no-harvest area (DEIS Chapter 2). The addition of wind buffers would widen the riparian protection, compared to Alternative B, and only restoration activities would be permitted. Harvests in riparian and wetland buffers would probably reduce the number of suitable cavities for nesting, however, the 50-foot no-harvest provision for wetlands, and the 25-foot no-harvest and minimal-harvest zones in the riparian buffer would ensure that some cavity trees near wetlands and stream banks would be retained. Openings created by some harvest entries may provide plant foods for species like the wood duck. Wind buffers, where designated, may provide additional area to buffers which could reduce disturbance and provide additional cavities for cavity-nesting ducks. The provision to retain three snags and five green trees per acre, as well as the provision to retain large, unique wildlife trees would also provide potential cavity trees for use by cavity-nesting ducks when located near riparian buffers. Under Alternative C, the larger and less disturbed riparian buffers and the no-harvest portion of the wetland buffers may increase nesting habitat suitability by providing more suitable cavity trees and snags adjacent to foraging and brooding areas, and reducing the probability of disturbance from human activities.

OESF Alternative 1

Under this alternative, riparian buffers average approximately 145, 135 and 95 feet on Type 1, 2, and 3 Waters, respectively. Wetlands protection is implemented according to DNR's FRP policies that require "no net loss of acreage or function." Wetland buffers have averaged 85 feet in width. Harvests occur according to FRP policy that allows timber removal only when adequate protection can be provided to fish and other nontimber resources.

OESF Action Alternatives

These alternatives have provisions that establish interior-core buffers averaging 150 feet on Type 1 and 2 Waters, and averaging 100 feet on Type 3 Waters. Exterior buffers (wind buffers) would be expected to average 150 feet on Type 1 through 3 Waters. Forested wetland buffers would be the same as under Alternative B. Riparian buffers would be designed to minimize mass-wasting potential and protect/aid natural restoration of physical processes and functions. Harvesting may occur when promoting these objectives. These buffers, and the restricted management activity within, are similar to the OESF No Action alternative except buffers established under the action alternatives would be wider. The addition of an exterior buffer would likely benefit cavity-nesting ducks if suitable cavity trees are retained within riparian zones. With the same snag and green tree retention conservation strategy as in Alternatives B and C, these alternatives would provide and protect more current and potential cavity trees than the No Action alternative..

Flammulated Owl (*Otus flammeolus*)
The flammulated owl is considered uncommon in Washington (Rodrick and Milner 1991), and is listed as a candidate species by the state (WDFW 1996), however, population studies have not been conducted in Washington and their abundance is unknown. The flammulated owl is one of the smallest North American owls and generally occurs in forested habitats over 3,000 feet in elevation east of the Cascade crest in Washington (Rodrick and Milner 1991; McCallum 1994). Flammulated owls are associated with open late-successional forests including ponderosa pine-dominated forests, mixed-conifer forests with a ponderosa pine component, and Douglas-fir-grand fir forests (Rodrick and Milner 1991; McCallum 1994). These owls nest in cavities excavated by woodpeckers, generally those made by the largest woodpecker species in the area. To forage for insects, these owls use open forest stands, open brushy areas, and forest/grassland edges (Rodrick and Milner 1991; McCallum 1994). Insecticide use and fire suppression may be detrimental to the flammulated owl.

ALTERNATIVE A AND ACTION ALTERNATIVES
The flammulated owl occurs in the three east-side planning units. Within these planning units, habitats types and amounts are evaluated as to their usefulness to spotted owls. Only a small portion of spotted owl habitat may serve as suitable flammulated owl habitat. Some forest stands considered unsuitable for spotted owls may constitute flammulated owl habitat, but a description of stand age, species composition, stand density, and elevation would be needed to evaluate this. The limited analysis of forest conditions in the east-side units precludes a complete evaluation of the effects of the alternatives for the flammulated owl, however each alternative would likely provide some suitable habitat.

Northern Goshawk (*Accipiter gentilis*)
In the Pacific Northwest, goshawks are strongly associated with late-successional coniferous forests and are most abundant in old growth (Thomas et al. 1993). Breeding goshawks use large tracts of mature and old-growth forest in which they can maneuver and forage below the canopy, and where large trees are available for nesting (Bartlet 1977; Hennessy 1978; Reynolds et al. 1982; Crocker-Bedford 1990a, 1990b; Marshall 1992b; Reynolds et al. 1992). They require trees large enough to provide a foundation for nest construction. Where nest sites are readily available, home range size is often determined by prey density (Reynolds et al. 1992). Home ranges for this species are extensive and vary between 5,000 and 6,000 acres, depending on local habitat quality (Reynolds 1983). Austin (1994) calculated a mean home range of 7,657 acres for adults in the southern Cascades, and demonstrated through statistical analysis that goshawks show a preference for closed-canopy mature/old-growth forests. There are apparently some similarities in the nesting habitat of northern goshawks and spotted owls. Spotted owl nests and goshawk nests have been located less than 100 yards from each other (Marshall 1992b). In mixed conifer forests on the east slope of the Cascades, 47 of 85 spotted owl nests occurred on stick nests built by goshawks (Buchanan et al. 1993).

Goshawk foraging areas comprise the largest portion of their home ranges and typically include a greater diversity of forest age classes and structural characteristics (e.g., snags, woody debris) than nest areas, and tend to support abundant avian prey populations (Reynolds et al. 1991). In general, foraging habitat consists of relatively open forest canopy, a well-developed shrub layer, and large trees (Reynolds et al. 1991). Large trees are used by goshawks as hunting perches, and canopy openings provide opportunities for prey capture. Foraging areas also tend to be comprised of a mixture of small (less than 4 acres), scattered openings and dense patches of mid-aged forests. Large tree components (live trees, snags, and downed logs) are scattered throughout the foraging area (Reynolds et al. 1991).

Goshawks may be highly sensitive to human disturbance. Timber harvesting within 0.25 mile (the nearest 125 acres) of goshawk nest sites in Idaho resulted in a 75 to 80 percent reduction in occupancy of their nesting territories (Patla 1990).

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands would be expected to provide at least some suitable breeding, foraging, and resting habitat of the northern goshawk. This habitat would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest that are expected to occur or develop within the system of protected riparian management zones and unstable slopes on all DNR-managed lands. A recent survey of timber sales sold on DNR-managed land since 1992 indicates no timber management activity has occurred in 77 percent of the riparian management zones established on Type 1 through 5 Waters on DNR-managed land, and timber management activity is prohibited on unstable slopes under this alternative, thus, some goshawk habitat is likely available in the riparian management zone.

Current management of spotted owl suitable habitat on DNR-managed lands would be expected to provide some additional goshawk habitat because some large tracts of older forest would be protected within the 40 percent suitable habitat maintained in each owl circle. However, this protection is expected to be short term in nature, since the suitable habitat may be harvested in the future if the territory is found to be unoccupied by spotted owls for 3 consecutive years. Some goshawk habitat may also be protected as a result of delaying harvest on stands considered to be murrelet habitat. However, these stands could be released for harvest after protocol surveys demonstrate no occupancy by murrelets. Under the No Action alternative, management of other forests on DNR-managed lands would provide no additional protection of large patches of goshawk habitat because DNR-managed lands outside of the WMZs, riparian management zones, spotted owl circles, and murrelet habitat are basically maintained at 60-year rotations. DNR does voluntarily protect some goshawk nests with a 30-acre buffer, however, there is no definitive time period for this protection nor is the protection guaranteed.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for northern goshawk breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of contiguous landscapes of sub-mature to old-growth forest. Additional goshawk habitat may also be provided as a result of delaying harvest on most stands considered to be murrelet habitat, until a long-term murrelet strategy is developed. Until that time, the amount of goshawk habitat provided by a murrelet conservation strategy would be unknown. In areas managed for spotted owl breeding habitat there would be two 500-acre nest groves per 5,000 acres of managed forest, and at least 50 percent of the designated NRF management areas in each WAU (inclusive of the nest groves) would be sub-mature forest (as defined in Hanson et al. 1993) or higher quality habitat. The strategy specifies that each nest grove would consist of 300 acres in high quality spotted owl nesting, roosting, foraging habitat, and 200 acres in sub-mature forest or higher quality habitat, i.e., roosting, foraging habitat (draft HCP Chapter IV). Under Alternative B, areas managed for spotted owl breeding habitat would total approximately 101,000 acres of the 202,000 acres designated for NRF function.

The riparian conservation strategy would result in 11-16 percent of the land base in a late-successional condition. High quality habitat in nest groves would occupy another 12 percent of the land base, but portions of the nest groves would be in riparian areas or on unstable hillslopes. The nest groves are estimated to occupy 10 percent of the land base outside of those areas protected by the riparian conservation strategy. Nest groves and the riparian conservation strategy result in late-successional forest over at least 21-26 percent of the area managed for spotted owl breeding habitat. Another 24-29 percent of the land base must be sub-mature forest or better to meet the 50 percent prescription. In total, 40-42 percent of the area managed for spotted owl breeding habitat would be sub-mature to old-growth forest. The landscape conditions in the areas managed as spotted owl breeding habitat would meet or exceed the habitat recommendations made by Reynolds et al. (1992).

Areas managed as spotted owl dispersal habitat include 200,000 acres, with at least 100,000 acres developed and maintained at any time. The purpose of dispersal habitat is to support the movement of juvenile spotted owls between sub-populations on federal reserves, and it is likely the availability of this habitat would enhance the survival of dispersing juvenile goshawks. At least 50 percent of the designated Dispersal management areas in each WAU would meet the minimum specifications for spotted owl dispersal habitat (draft HCP Chapter IV).

Management of spotted owl NRF habitat under Alternative B would be expected to provide more northern goshawk habitat than the No Action alternative. Some suitable habitat that meets the minimum patch size requirement for this species may be protected within spotted owl NRF habitat outside of established riparian management zones and wetland buffers. Spotted owl dispersal habitat under this alternative in the west-side planning units would be managed for young-forest marginal characteristics (Hanson et al. 1993) which include the canopy closure, tree density and height, and vertical diversity that contribute to the habitat needs of the goshawk.

Management of the riparian ecosystem under this alternative would be expected to provide some northern goshawk habitat. Some potential nest trees in the riparian zones would be retained or developed over the term of the HCP. As stands adjacent to the riparian buffers develop under the proposed harvest regime rotation age of 50-100 years, they may provide adequate closed canopy contiguous blocks of forest suitable for goshawks. Since riparian buffers would be wider than in the No Action alternative, the potential to develop goshawk habitat would be greater under this alternative.

DNR would not allow activities that may appreciably reduce the likelihood of successful nesting within 0.55 miles of a known active goshawk nest which is located in the areas managed for spotted owl breeding between April 1 and August 31. A circle of radius 0.55 miles circumscribes the entire post-fledgling family area (600 acres). This protection would serve to minimize human disturbance around active nest sites.

In addition, the strategy to retain three snags and five green trees per acre of harvest would benefit goshawks by providing habitat for prey species and potential future nest trees in upland areas. This conservation measure is enhanced by the added provisions to include one tree from the largest diameter size class, and to retain large, structurally unique trees valuable to wildlife, where possible. This conservation measure would complement the owl and riparian strategies to provide more habitat than that provided under Alternative A.

ALTERNATIVE C

The combination of the riparian and spotted owl conservation strategies should provide slightly more forest conditions suitable for northern goshawk breeding, foraging, and resting habitat than Alternative B. This would be reflected in the additional areas managed for spotted owl breeding habitat, and the wider riparian buffers. In concert, these strategies should ensure the development of somewhat larger contiguous landscapes of sub-mature to old-growth forest than Alternative B. Additional goshawk habitat may also be provided as a result of delaying harvest on most stands considered to be murrelet habitat, until a long-term murrelet strategy is developed. Until that time, the amount of goshawk habitat provided by a murrelet conservation strategy would be unknown.

In areas managed for spotted owl breeding habitat, at least 60 percent of the designated NRF management areas in each WAU would be sub-mature forest or higher quality habitat (202,200 of the 337,000 acres designated for NRF function. In areas managed for spotted owl dispersal habitat (172,000 acres), 86,000 acres would be developed and maintained at any point in time (DEIS Chapter 2).

Management of the riparian ecosystem under this alternative would be expected to provide some northern goshawk habitat. Some potential nest trees in the riparian zones would be retained or developed over the term of the HCP. As stands adjacent to riparian buffers develop, they may provide adequate closed canopy contiguous blocks of forest suitable for goshawks. Since riparian buffers would be wider than Alternative B (DEIS Chapter 2) and the No Action alternative, the potential to develop goshawk habitat would be greatest under this alternative.

The snag and green tree retention conservation measure, as well as the restriction on activities within 0.55 miles of a known active goshawk nest, within NRF-designated areas, would be the same as under Alternative B. As such, the benefits to goshawks would be the same and complementary to the owl and riparian conservation strategies, which wold be more beneficial to goshawks than what is provided under Alternative A.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF would be expected to provide at least some breeding, foraging, and resting habitat of the northern goshawk. Similar to the HCP No Action alternative, this protection would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest that are expected to occur or develop within the system of protected riparian management zones and unstable slopes in the OESF. Timber management activity is prohibited in the mass-wasting buffer of the riparian management zones and on unstable slopes under this alternative. Spotted owl dispersal habitat, as well as management of other forests, on the OESF would be the same as that described for the No Action alternative above.

OESF ACTION ALTERNATIVES

Management of the riparian ecosystem on the OESF would be the same for both action alternatives. This strategy would be expected to provide some breeding, foraging, and resting habitat of the northern goshawk. Ecosystem protection under these alternatives is intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which is expected to benefit all species associated with late-successional and old-growth forests such as the northern goshawk. More specific protection of the habitat for this species would occur primarily from the establishment of, and restriction of timber harvest activities in, mass-wasting buffers within riparian management zones (including unstable slope areas) (draft HCP Chapter IV, DEIS Chapter 2).

OESF ALTERNATIVE 2

Management of spotted owl NRF habitat under this alternative would be expected to provide some protection of breeding, foraging, and resting habitat of the northern goshawk. Management of spotted owls under this alternative would be expected to be achieved through the protection and restoration of the ecosystem functions of older forests. This management activity would provide some large contiguous tracts of older forest that would likely function as suitable habitat for use by goshawks. The landscape would be expected to have 40 percent suitable spotted owl habitat, 20 percent of which would be old forest, distributed throughout the OESF. In addition, the strategy to retain three snags and five green trees peracre of harvest would benefit goshawks by providing for prey species and potential future nest trees in upland areas. This conservation measure is enhanced by the added provisions to include one tree from the largest diameter size class and to retain large, structurally unique trees valuable to wildlife, where possible. Together, the owl strategy, the snag and leave tree strategy, and the guaranteed riparian and wetland management zones would provide adequate suitable goshawk habitat throughout the OESF. This goshawk habitat would be more than that provided under the No Action alternative.

OESF ALTERNATIVE 3

This alternative would focus on a stratified management design to develop nesting, roosting, and foraging habitat configurations that would attract and support territorial owls (DEIS Chapter 2). Where these areas occur, management in the annual home range area would maintain and/or restore 40 percent young-forest marginal, sub-mature, and old-forest habitat conditions. These habitats contribute to the mosaic of habitat conditions required by the goshawk and, as such, would provide adequate habitat to support this species. However, this habitat would not be available throughout the OESF but in concentrated areas based on spotted owl life requisites. Nevertheless, the owl strategy, the snag and green tree retention strategy described in Alternative 2, and the guaranteed riparian and wetland management zones, would provide adequate suitable goshawk habitat in the OESF. This goshawk habitat would be more than that provided under the No Action alternative.

Golden Eagle (*Aquila chrysaetos*)

The principal threat to the golden eagle in Washington is the destruction of open rangeland habitat, with which it is most commonly associated. Prior to 1982, nesting of the golden eagle west of the Cascade mountains in Washington State was considered rare (Bruce et al. 1982). In western Washington, nest sites are primarily in large trees within mature or old-growth forests near the edge of clearcuts (Rodrick and Milner 1991). Clearcut logging creates forest conditions highly favorable to golden eagles (Bruce et al. 1982), i.e., it hunts for mammals (rabbits, squirrels, mountain beaver) in large open areas, and therefore, current forest practices appear to have expanded the amount of suitable golden eagle habitat. Golden eagles use the same territory annually, but use alternate nests in different years (Rodrick and Milner 1991). Golden eagles may nest in large trees or on cliffs, and nesting occurs between January 15 and July 15 (Rodrick and Milner 1991). Golden eagles can persist in intensively managed forests where timber harvests create a distribution of different seral stages within drainage basins.

ALTERNATIVE A

Current management activities are likely providing or protecting some golden eagle habitat, although it is probably incidental, as a result of the riparian buffers and protection of owl territories under the ESA. Nesting and perching sites may be protected by the riparian buffers that have been averaging 196 feet on Type 1 and 2 Waters. In addition, current timber harvest practices have created a mosaic of forest stands of various ages, from clearcuts to 60 years old. This management activity creates a landscape with some foraging habitat for the golden eagle. However, the riparian buffers are not guaranteed, and the only protection of golden eagle habitat required by law is under the Bald and Golden Eagle Protection Act (16 U.S.C. § 668 et seq.), which specifies protection for the eagle and eagle nests from disturbance.

ALTERNATIVE B

The combination of the riparian conservation strategy and forest management in the west-side planning units should provide breeding, foraging, and resting habitat for the golden eagle. Many forests on unstable hillslopes would not be harvested and some of these areas would contain large trees. Management activities within the riparian buffer must maintain or restore the quality of salmonid habitat. This management is expected to result in the development of late-successional forest containing large live trees. The ecological integrity of the riparian buffer, and the eagle nesting sites contained therein, would be protected by wind buffers. Even-aged forest management throughout the west-side planning units would continue to provide openings for foraging habitat. In areas managed for spotted owl breeding habitat, at least 50 percent of the areas in each WAU would be sub-mature forest or higher quality habitat with old-growth quality features. In total, approximately 40 percent of the area managed for spotted owl breeding habitat would be sub-mature to old-growth forest which should provide an adequate supply of potentially suitable nest trees. Cliffs may also be used as nest sites for golden eagles. Under Alternative B, there is a provision for some cliff protection whereby mining of rock from cliffs for road construction would be avoided when materials can otherwise be reasonably acquired, although this would not be guaranteed protection from disturbance. DNR would also evaluate, in coordination with USFWS, and protect the integrity of cliffs judged suitable for and likely to be used by wildlife. Trees along the base and top of cliffs suitable for nesting raptors would be retained. In addition, very large old trees specified for retention under this alternative would be available as potential nest trees for golden eagles. The potential habitat provided for golden eagles under Alternative B would be substantially more than that provided under the No Action alternative.

ALTERNATIVE C

This alternative contains the same protection for golden eagles as Alternative B except Alternative C would have more spotted owl breeding habitat. In areas managed for spotted owl breeding habitat, at least 60 percent of the areas in each WAU would be sub-mature forest or higher quality habitat with old-growth quality features which would provide an adequate supply of potentially suitable nest trees. Cliffs and large, old tree protection is the same as under Alternative B, therefore, the potential habitat provided for golden eagles under Alternative C would be slightly more than Alternative B and greater than that provided under the No Action alternative.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF would be expected to provide at least some breeding, foraging, and resting habitat of the golden eagle. Similar to the HCP No Action alternative, this protection would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest that are expected to occur or develop within the system of protected riparian management zones and unstable slopes in the OESF. Timber management activity is prohibited in the mass-wasting buffer of the riparian management zones and on unstable slopes under this alternative. These buffers likely provide some big trees and snags that could potentially function as nest and perch trees. In addition, current timber harvest practices have created a mosaic of forest stands of various ages, from clearcuts to 60 years old. This management activity creates a landscape with some foraging habitat for the golden eagle.

OESF Alternative 2

Management of spotted owl NRF habitat under this alternative would be expected to provide some protection of breeding, foraging, and resting habitat of the golden eagle. Ecosystem protection under this alternative is intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands. The old forest condition is expected to cover nearly 30 percent of the OESF in the long term. Older forests would be well-connected across the OESF because of their association with the stream network, which has guaranteed buffers. Riparian buffers and the older forest conditions developed from the owl conservation strategy should provide an potential nest trees. In addition, the provisions addressing cliffs and very large, old trees in Alternatives B and C above would also apply to management activities on the OESF. These management activities would provide habitat that fulfills all life requisites of the golden eagle, and are substantially greater than the OESF No Action alternative.

OESF ALTERNATIVE 3

The protection and development of owl habitat necessary to support territorial owls would also develop and enhance habitat for the golden eagle. Management for owl breeding habitat would complement the riparian strategy and provide old forest habitat in concentrated areas. This strategy is expected to provide a source of nest and perch sites for golden eagles, as well as foraging areas where this habitat is adjacent to younger seral stages of forest growth. In addition, the provisions addressing cliffs and very large, old trees in Alternatives B and C above would also apply to management activities on the OESF. These management activities would provide habitat that fulfills all life requisites of the golden eagle, and are substantially greater than the OESF No Action alternative.

Sandhill Crane (*Grus canadensis*) and Black Tern (*Chlidonias niger*)

Sandhill crane and black tern utilize similar habitats in Washington State. Thus, for the purposes of this assessment, breeding, foraging, and resting habitats are considered to be provided by nonforested wetlands as described below. Since their habitats are similar, the assessment of the effects of the alternatives on these species has been combined.

Sandhill Crane

Sandhill crane migrants occur throughout the state and breeding has been documented in both eastern and western Washington (WDFW 1994a; W. Vogel, USFWS, Pacific Northwest Habitat Conservation Plan Program, Olympia, WA, pers. commun.,1995). Sandhill cranes are extremely wary and therefore use only large tracts of open habitat with good visibility (WDFW 1994a). Potential habitat for this species includes grain fields, wet meadows, large marshes (i.e., nonforested wetlands), and shallow ponds (Type 2 and 3 Waters) (Brown 1985; WDFW 1994a). Nesting habitat consists of extensive shallow-water marshes with dense emergent plant cover (Littlefield and Ryder 1968). Wet meadows and grasslands are used for foraging and resting habitat (Brown 1985; WDFW 1994a).

Black Tern

The black tern is a common summer resident in eastern Washington and a migrant in western Washington (Wahl and Paulson 1991). The black tern appears to migrate primarily along the coast (Haley 1984), but is also expected to use the Columbia River as a route from breeding areas in eastern Washington and British Columbia.

Potential breeding (east-side planning units only), foraging, and resting habitat for the black tern is considered to include inland lakes, ponds, reservoirs, freshwater marshes, and wet meadows. Nests of this species in Washington are found on the east side of the Cascade mountains on pond and lake shorelines, marshes, swamps, bogs, and wet meadows (Brown 1985; National Geographic Society 1987). During the nesting season, black terns feed on insects and small fish (Haley 1984).

ALTERNATIVE A

Current management of the riparian ecosystem on DNR-managed lands is expected to provide some suitable foraging and resting habitats for the black tern, and foraging, resting and breeding habitat for the sandhill crane. Protection of this habitat is primarily through the establishment of riparian management zones on Type 2 Waters and WMZs on nonforested wetlands. No timber management activity has occurred in over 75 percent of the riparian management zones established on Type 2 Waters on DNR-managed land since 1992, which includes the lakes and ponds that provide foraging and resting habitat for these species in the HCP planning area. Under DNR's FRP policies, this protection of riparian buffers is expected to continue. Furthermore, under this alternative, timber harvest activities are restricted in WMZs established on nonforested wetlands which include the wet meadows, marshes, lakes and ponds that provide potential habitat for these species. Additional protection of sandhill crane habitat is provided by the state designation of critical wildlife habitat for the sandhill crane under WAC 222-16-080, which includes the area within 0.25 mile of a documented breeding area (WFPB 1995c). Some suitable resting and foraging habitat for this species is assumed to occur within this 0.25-mile buffer for this species.

ALTERNATIVE B

Management of the riparian ecosystem under Alternative B is expected to provide adequate amounts of foraging and resting habitats for the black tern, and foraging, resting and breeding habitat for the sandhill crane in the west-side planning units. Specific benefits of this alternative for these species that would provide some guaranteed protection of aquatic habitats include the establishment and protection of wetland buffers, and of riparian management zones on Type 2 Waters. Protection of aquatic habitat would be provided by the prohibition of harvest within a 25-foot no-harvest area within each zone established, and the constraint on activities within the remainder of the zone to those that are expected to maintain or restore the quality of salmonid habitat. In addition, wind buffers on the windward side of Type 1 and 2 Waters would help to maintain the integrity of the riparian buffers, adding to the protection of the aquatic habitat. This protection is greater than that provided under the No Action alternative for the black tern, and would be in addition to that afforded the sandhill crane by the state critical wildlife habitat designation.

ALTERNATIVE C

Management of the riparian ecosystem under Alternative C is expected to provide adequate foraging and resting habitats for the black tern, and foraging, resting and breeding habitat for the sandhill crane. Specific benefits of this alternative are the same as under Alternative B except wind buffers would be established on both sides of Type 1 and 2 Waters, and the constraint on activities within the buffer zone would be restricted to those that are expected to restore or enhance the quality of salmonid habitat. This protection is substantially greater than that provided under the No Action alternative for the black tern, and would be in addition to that afforded the sandhill crane by the state critical wildlife habitat designation.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The sandhill crane and black tern are not known to occur in the OESF. Therefore, an analysis of these alternatives is unnecessary.

Vaux's Swift (*Chaetura vauxi*)

Vaux's swift is a breeding-season resident of the Pacific Northwest, and winters from central Mexico to northern South America (Erhlich et al. 1988). The species nests in late-successional coniferous forests (Bull and Collins 1993). There are indications that it depends on old-growth forests for survival (Carey 1989). The species requires large hollow snags or cavities in the broken tops of live trees for nesting and night roosting. Nest snags west of the Cascades are at least 12 meters (40 feet) tall and 63.5 centimeters (25 inches) dbh (Brown et al. 1985). Hundreds of Vaux's swifts may use a single large hollow tree for night roosting. There is usually one nest per tree. They exploit all seral stages while foraging (Brown 1985), but show a strong preference for spaces over water (Bull and Beckwith 1993).

ALTERNATIVE A

Current management under the Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for Vaux's swift nesting or roosting. At least three snags per acre have been left after timber harvest, however, there is no guarantee that they will be suitable. The current riparian strategy has resulted in no-harvest buffers averaging 196 feet (range = 0-350 feet) along Type 1 and 2 Waters, and 89 feet (range = 0-300 feet) along Type 3 Waters. Wetland buffers have averaged 86 feet. It is likely that the buffers, combined with the Washington Forest Practices Rules leave tree retention requirement, likely provide some suitable snags and large trees which may be suitable for Vaux's swifts.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for Vaux's swift breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live trees and snags. Areas managed for spotted owl breeding habitat would provide a target condition of at least 50 percent of the landscape measured within each WAU (draft HCP Chapter IV). Many forests on unstable hillslopes would not be harvested and some of these areas would contain large live trees and large snags. Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would protect breeding and resting habitat. Management within the riparian buffer, in particular in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics and suitable snags for Vaux's swifts. Wetlands would have buffers at least 100 feet wide, which would maintain the integrity of potential foraging areas, as well as provide a source of potential snags. In addition, under Alternative B, very large, old trees would be specified for retention (draft HCP Chapter IV), as well as trees or snags that are known to be used by Vaux's swifts as night roosts or are known to contain active Vaux's swifts nests. The large, old trees would be selected for their unique structural characteristics or because they are considered to be old-growth remnants. Under the snag and green tree retention strategy, three snags per acre harvested would be retained with a preference shown for protection of hard snags with bark, greater than 40 feet in height where available, and one of the five green trees being retained per acre harvested would belong to the size class of the largest diameter living trees in the harvest unit. These green trees would have the potential to become suitable snags for Vaux's swift in the future. Under Alternative B, the protection and maintenance of potential Vaux's swift habitat, as well as known occupied sites, is guaranteed and is substantially greater than that provided under the No Action alternative.

ALTERNATIVE C

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for Vaux's swift breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live trees and snags. Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2). Many forests on unstable hillslopes would not be harvested and some of these areas would contain large live trees and large snags. Outside of the areas managed for spotted owl breeding habitat, riparian and wetland protection is the same as under Alternative B, as well as the provision to retain very large, old trees, and known roosts. Like Alternative B, Alternative C would have the snag and green tree retention strategy. The protection and maintenance of potential Vaux's swift habitat, as well as known occupied sites, is guaranteed under this alternative, and is substantially greater than that provided under the No Action alternative.

OESF ALTERNATIVE 1

Current management under Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for Vaux's swift nesting or roosting. At least three snags have been left per acre after timber harvest, however, there is no guarantee that they will be suitable. The current riparian strategy on the OESF establishes buffers based on mass-wasting potential, in which no timber harvest is allowed. This strategy has resulted in buffers averaging approximately 145 and 135 feet on Type 1 and 2 Waters, and 95 feet along Type 3 and 4 Waters. These buffers incur no management activity and, therefore, likely contain snags suitable for Vaux's swift roosting and nesting.

OESF ALTERNATIVE 2

Under this alternative, each landscape planning unit would have a 40 percent threshold amount of nesting, roosting and foraging habitat for owl, of which half would be older forest habitat. This strategy, the riparian strategy specifying stream buffers averaging 150 feet along Type 1 and 2 Waters, and averaging 100 feet along Type 3 and 4 Waters, and wetland buffers at least 100 feet in width, would likely provide an adequate amount of suitable snags for Vaux's swift. In addition, specific provisions for protection of very large, old trees, snag and green tree retention, and protection of known Vaux's swift night roosts and active nests as described in Alternative B would be implemented. This protection and maintenance of potential Vaux's swift habitat is guaranteed and substantially greater than that provided under the OESF No Action alternative.

OESF ALTERNATIVE 3

Under this alternative, management would concentrate on areas with a likely potential to support owl pairs, and several special pair areas (DEIS Chapter 2). Annual range areas would be managed so that at least 40 percent of the area would be in young-forest marginal or better habitat. This strategy, and the riparian and wetlands protection under OESF Alternative 2, would likely provide an adequate amount of suitable snags for Vaux's swift. In addition, specific provisions for protection of very large, old trees, snag and green tree retention, and protection of known Vaux's swift night roosts and active nests as described in Alternative B would be implemented. This protection and maintenance of potential Vaux's swift habitat is guaranteed and substantially greater than that provided under the OESF No Action alternative.

Lewis' Woodpecker (*Asyndesmus lewis*)

Lewis' woodpecker breeds throughout most of Washington (Rodrick and Milner 1991). Lewis' woodpecker is associated with open ponderosa pine forests and cottonwood riparian areas (Rodrick and Milner 1991; Erhlich et al. 1988). It also uses selectively logged or burned coniferous forest and oak woodlands (Rodrick and Milner 1991). The species excavates nest cavities, but will also occupy natural cavities or cavities excavated by other woodpeckers. The species uses a hawking technique to capture insects, and prefers riparian deciduous forest and early seral coniferous forest as foraging habitat (Brown 1985).

ALTERNATIVE A

Current management under Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for Lewis' woodpecker. Snags are required to be left after timber harvest, however, there is no guarantee that they will be suitable. The current riparian strategy has resulted in no-harvest buffers averaging 196 feet (range = 0 to 350 feet) along Type 1 and 2 Waters, and 89 feet (range = 0 to 300 feet) along Type 3 Waters. Wetland buffers have averaged 86 feet. It is likely that the buffers, combined with the Washington Forest Practices Rules leave tree retention requirement, likely provide some suitable snags and large trees which may be suitable for Lewis' woodpeckers. Riparian buffers may also protect some oak woodlands and cottonwoods utilized by Lewis' woodpecker. Additional potential Lewis' woodpecker habitat would likely be available in protected spotted owl territories, however, as the stands become unoccupied by spotted owls they would likely be harvested. As such, protection of Lewis' woodpecker habitat would be incidental and temporary.

ALTERNATIVE B

The riparian conservation strategy could provide breeding, foraging, and resting habitat for Lewis' woodpecker. Riparian buffers would be established as described in DEIS Chapter 2 and draft HCP Chapter IV. The ecological integrity of the riparian buffer, and the Lewis' woodpecker habitat contained therein, would be protected by wind buffers. Where there is at least a moderate potential for windthrow, Type 1 and 2 Waters, and Type 3 Waters greater than 5 feet wide, would be protected by an additional wind buffer. Areas managed for spotted owl breeding habitat would provide a target condition of at least 50 percent of the landscape measured within each WAU (draft HCP Chapter IV).

This management is expected to result in the development of late-successional forest containing a variety of snags. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live trees and snags. Ecosystem restoration within the riparian buffer would try to maintain the natural mix of conifer and deciduous species. The riparian conservation strategy is expected to guarantee some protection of Lewis' woodpecker oak woodlands habitat. No harvest would occur on hillslopes with a high risk of mass wasting, and some oak forest may exist within or immediately below unstable areas. In addition, this alternative contains special provisions for protecting oak woodlands, very large, structurally unique trees, and retaining three snags and five green trees per acre harvested (Appendix 3, Chapter IV, Section F). These provisions would protect current and future potential Lewis' woodpecker habitat. These conservation measures are greater than under the No Action alternative because of the owl conservation strategy, guaranteed riparian buffers, and the special provisions to protect potential Lewis' woodpecker habitat in oak woodlands and large, structurally unique trees, and snags.

ALTERNATIVE C

The conservation measures that benefit Lewis' woodpecker under this alternative are similar to Alternative B, except Alternative C would have more owl breeding habitat, and added wind buffers in the riparian zones (DEIS Chapter 2). Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2). This management is expected to result in the development of late-successional forest containing large snags. Like Alternative B, this alternative also contains special provisions for protecting oak woodlands, large, structurally unique trees, and providing snags and green trees as current and future habitat (DEIS Chapter 2). These conservation measures are greater than under the No Action alternative because of the owl conservation strategy, guaranteed riparian buffers, and the special provisions to protect potential Lewis' woodpecker habitat in oak woodlands and large, structurally unique trees and snags.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

Lewis' woodpecker is most frequently found in open ponderosa pine forests and cottonwood riparian areas. The OESF does not contain either of these forest habitats, and Lewis' woodpecker is not commonly found in the OESF. Thus, an assessment of the OESF No Action and action alternatives is unnecessary.

Pileated Woodpecker (*Dryocopus pileatus*)

The pileated woodpecker occurs in forested areas throughout the state of Washington. The species inhabits mature and old-growth forests with large snags and fallen trees. The best habitat appears to be conifer stands with two or more canopy layers, with the uppermost being 80-100 feet high (Rodrick and Milner 1991). Pileated woodpeckers excavate nest cavities in snags or live trees with dead wood. Roost tree characteristics are similar to those of nest trees (Rodrick and Milner 1991). Within their home range, pileated woodpeckers show a preference for foraging in forests 40 years or older and in riparian areas (Mellen et al. 1992), where they search for insects on large snags, logs, and stumps.

ALTERNATIVE A

Current management under the Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for the pileated woodpecker. Snags and green recruitment trees are required to be left after timber harvest. Although there is no guarantee that the snags will be suitable, it is likely that the green recruitment trees will be suitable some time in the future. In western Washington, three wildlife reserve trees (typically snags) are left for each acre harvested. The wildlife reserve trees must be 10 or more feet in height and 12 or more inches dbh. The current riparian strategy has resulted in buffers averaging 196 feet along Type 1 and 2 Waters, and 89 feet along Type 3 Waters. Wetland buffers have averaged 86 feet. It is likely that the buffers, combined with the Washington Forest Practices Rules leave tree retention requirement, likely provide some suitable snags and large trees which may be suitable for pileated woodpeckers. Additional potential pileated woodpecker habitat would likely be available in protected spotted owl territories, however, as the stands become unoccupied by spotted owls they would likely be harvested. As such, protection of pileated woodpecker habitat would be incidental and temporary.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for pileated woodpecker breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live tree and snags. In areas managed for spotted owl breeding habitat at least 50 percent of each WAU would be sub-mature forest or better, and there would be two 500-acre nest groves per 5,000 acres of managed forest. The strategy specifies that each nest grove would consist of 300 acres in high quality spotted owl nesting, roosting, foraging habitat, and 200 acres in sub-mature forest or better, i.e., roosting, foraging habitat (draft HCP Chapter IV). The high quality habitat in nest groves would have old-growth forest characteristics and cover approximately 20,000 acres. Many forests on unstable hillslopes would not be harvested and some of these areas would contain large, live trees and large snags. Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would protect pileated woodpecker breeding and resting habitat. Riparian buffers would be established as described in DEIS Chapter 2 and draft HCP Chapter IV. The ecological integrity of the riparian buffer, and the pileated woodpecker habitat contained therein, would be protected by wind buffers. Management within the riparian buffer, and on hillslopes with a high risk of mass wasting, in particular in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. This habitat would contain suitable large trees and snags preferred by pileated woodpeckers. In addition, under this alternative, very large, structurally unique trees would be retained, as part of the snag and green tree retention strategy, providing potential future suitable nest and roost sites for pileated woodpecker. Preference would be shown for hard snags with bark at least 20 inches dbh. Where possible, snags 40 feet high would be retained. This protection would be guaranteed and would be substantially greater than under the No Action alternative.

ALTERNATIVE C

The conservation measures that benefit the pileated woodpecker under this alternative are similar to Alternative B, except Alternative C would have more owl breeding habitat, and added wind buffers in the riparian zones (DEIS Chapter 2). Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2). Many forests on unstable hillslopes would not be harvested and some of these areas would contain large live trees and large snags. Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would protect breeding and resting habitat. Management within the riparian buffer, in particular in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics, and suitable snags and large trees for pileated woodpeckers. Like Alternative B, this alternative also contains special provisions for protecting very large, old trees (DEIS Chapter 2) providing potential future suitable nest and roost sites for pileated woodpecker, and for retaining additional snags and green trees. This protection is guaranteed and is substantially greater than under the No Action alternative.

OESF Alternative 1

Current management under Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for pileated woodpecker nesting or roosting. Snags are required to be left after timber harvest, however, there is no guarantee that they will be suitable. The current riparian strategy on the OESF establishes buffers based on mass-wasting potential, in which no timber harvest is allowed. This strategy has resulted in buffers averaging approximately 145 and 135 feet on Type 1 and 2 Waters, respectively. Buffers on Type 3 Waters have averaged 95 feet. These buffers incur no management activity and, therefore, likely contain snags and large trees suitable for pileated woodpecker roosting and nesting. Additional potential pileated woodpecker habitat would likely be available in protected spotted owl territories, however, as the stands become unoccupied by spotted owls they would likely be harvested. As such, protection of pileated woodpecker habitat would be incidental and temporary.

OESF Alternative 2

Under this alternative, each landscape planning unit would have a 40 percent threshold amount of nesting, roosting and foraging habitat for spotted owls, of which half would be older forest habitat. This strategy and the riparian strategy specifying interior-core stream buffers averaging 150 feet along Type 1 and 2 Waters, and 100 feet along Type 3 and 4 Waters, with additional exterior buffers, would likely provide an adequate amount of suitable snags and large trees for pileated woodpecker nesting and roosting. The provision for retaining very large, old trees, and snags and green trees described in Alternatives B and C above would also apply to this OESF action alternative. This protection and maintenance of potential pileated woodpecker habitat is guaranteed and substantially greater than that provided under OESF Alternative 1.

OESF Alternative 3

Under this alternative, management would concentrate on areas with a likely potential to support spotted owl pairs, and several special pair areas (DEIS Chapter 2). Annual range areas would be managed so that at least 40 percent of the area would be in young-forest marginal or better habitat. This strategy and the riparian strategy described in Alternative 2 would likely provide some suitable snags and large trees for pileated woodpeckers. The provision for retaining very large, old trees, and snags and green trees described in Alternatives B and C above would also apply to this OESF action alternative. This protection and maintenance of potential pileated woodpecker habitat is guaranteed and greater than that provided under the OESF No Action alternative.

Olive-sided Flycatcher (*Contopus borealis*)

The preferred habitat of the olive-sided flycatcher is late-successional coniferous forest (Brown 1985), in particular, open coniferous forest with tall standing dead trees (Bent 1963). The species is often found along forest edges, where it perches on tall, exposed snags. On the western Olympic Peninsula, the bird is usually detected where late-successional forest is bordered by clearcut (Sharpe 1992). Nests are typically constructed on a horizontal branch between 15 and 50 feet above the ground (DeGraaf et al. 1991) in a variety of tree species -- cedars, firs, spruces, and alders (Bent 1963).

ALTERNATIVE A

There are no established management recommendations for the olive-sided flycatcher. The creation of forest edges through clearcutting probably benefits the species by providing foraging opportunities, but extensive clearcutting with short harvest rotations would eliminate the mature forests and tall snags which this species requires (Sharpe 1992). Current management of the riparian ecosystem on DNR-managed lands would be expected to provide at least some suitable breeding, foraging, and resting habitat of the olive-sided flycatcher. This habitat would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest that are expected to occur or develop within the system of protected riparian management zones, and by the establishment of mass-wasting buffers on steep and unstable slopes.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for olive-sided flycatcher breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest. In areas managed for spotted owl breeding habitat there would be two 500-acre nest groves per 5,000 acres of managed forest, and at least 50 percent of each WAU (inclusive of the nest groves) would be sub-mature forest (as defined in Hanson et al. 1993) or better. The strategy specifies that each nest grove would consist of 300 acres in high quality spotted owl nesting, roosting, foraging habitat, and 200 acres in sub-mature forest or better, i.e., roosting, foraging habitat.

Outside of the areas managed for spotted owl breeding habitat, the riparian conservation strategy would protect breeding, foraging, and resting habitat. Management within the riparian buffer, in particular in the no-harvest and minimal-harvest areas, should eventually result in stands with mature and old-growth characteristics. Mature and old-growth forests would also exist on hillslopes with a high risk of mass wasting. This protection is greater than that provided by the No Action alternative because more habitat is provided by the wider guaranteed riparian buffers, and the owl conservation strategy that provides older forests for owl nesting, roosting and foraging habitat. In addition, this alternative also contains a provision for conserving large, old trees important to wildlife, as part of the snag and green tree retention strategy, which eventually may become snags preferred by the olive-sided flycatcher.

ALTERNATIVE C

Under this alternative, protection of 10 percent additional acres of designated NRF areas over that provided under Alternative B would provide substantially more habitat utilized by the olive-sided flycatcher than the No Action alternative. The riparian management zones and wetland buffers established under this alternative would add more protection than Alternative B above (DEIS Chapter 2), therefore this protection is greater than that provided under the No Action alternative. In addition, this alternative also contains a provision for conserving large, old trees important to wildlife, as part of the snag and green tree retention strategy, which eventually may become snags preferred by the olive-sided flycatcher.

OESF ALTERNATIVE 1

Current management of the riparian ecosystem on the OESF would be expected to provide at lease some breeding, foraging, and resting habitat of the olive-sided flycatcher. Similar to the HCP No Action alternative, this protection would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest that are expected to occur or develop within the system of protected riparian management zones and unstable slopes in the OESF. Timber management activity is prohibited in the mass-wasting buffer of the riparian management zones and on unstable slopes under this alternative. Spotted owl dispersal habitat, as well as management of other forests, on the OESF would be the same as that described for the No Action alternative above.

OESF ACTION ALTERNATIVES

Management of the riparian ecosystem on the OESF would be the same for both action alternatives. This strategy would be expected to provide some breeding, foraging, and resting habitat of the olive-sided flycatcher. Ecosystem protection under these alternatives is intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands which is expected to benefit all species associated with late-successional and old-growth forests. More specific protection of the habitat for this species would occur primarily from the establishment of, and restriction of timber harvest activities in, mass-wasting buffers within riparian management zones (including unstable slope areas). This strategy would likely ensure some olive-sided flycatcher habitat would be distributed throughout the OESF.

OESF ALTERNATIVE 2

Under this alternative, each landscape planning unit would have a 40 percent threshold amount of nesting, roosting and foraging habitat for spotted owls, of which half would be older forest habitat. This strategy and the riparian strategy specifying interior-core stream buffers averaging 150 feet along Type 1 and 2 Waters, and 100 feet along Type 3 and 4 Waters, with additional exterior buffers, would likely provide an adequate amount of suitable snags and large trees for olive-sided flycatchers distributed throughout the OESF. The provision for retaining very large, old trees described in Alternatives B and C above would also apply to this OESF action alternative. This protection and maintenance of olive-side flycatcher habitat is guaranteed and substantially greater than that provided under OESF Alternative 1.

OESF ALTERNATIVE 3

Under this alternative, management would concentrate on areas with a likely potential to support spotted owl pairs, and several special pair areas (DEIS Chapter 2). Annual range areas would be managed so that at least 40 percent of the area would be in young-forest marginal or better habitat. This strategy and the riparian strategy described in Alternative 2 would likely provide some suitable snags and large trees for olive-sided flycatchers, although the owl habitat would be restricted to special areas of concentration. The provision for retaining very large, old trees described in Alternatives B and C above would also apply to this OESF action alternative. This protection and maintenance of potential olive-sided flycatcher habitat is guaranteed and greater than that provided under the OESF No Action alternative.

Little Willow Flycatcher (*Empidonax trailli brewstri*)

The preferred habitat of the little willow flycatcher is stands of alder or willow, thickets of salmonberry or blackberry (Sharpe 1992), and low dense shrubby vegetation. In drier climates the species is mainly a riparian species. In wetter climates, such as the western Olympic Peninsula, it has also been observed using shrubby habitats in regenerating clearcuts (Sharpe 1992) and in sapling stands between 10 and 20 years old. Nests are typically constructed in horizontal forks or upright crotches of shrubs or small trees between 3 and 25 feet above the ground (DeGraaf et al. 1991). A variety of woody plant species are used for nesting -- alders, willow, and buttonbush (DeGraaf et al. 1991).

ALTERNATIVE A

There are no established management recommendations for the little willow flycatcher. Where little willow flycatchers are strongly associated with riparian habitat, such as the eastern Olympic peninsula, the preservation of riparian areas would be critical for the species. On the western Peninsula and in the western Cascades, even-aged forest management should provide the type of nesting habitat that the species requires. Riparian and wetland buffers currently being established (DEIS Chapter 2) are adequate for providing some little willow flycatcher habitat, however, this protection is not guaranteed.

ALTERNATIVE B

The riparian conservation strategy and forest management in the west-side planning units should provide breeding, foraging, and resting habitat for the little willow flycatcher. Riparian buffers would be established as described in DEIS Chapter 2 and HCP Chapter IV. Ecosystem restoration within the riparian buffer would try to maintain the natural mix of conifer and deciduous species. The ecological integrity of the riparian buffer, and the little willow flycatcher habitat contained therein, would be protected by wind buffers as described in DEIS Chapter 2. Wetland buffers would also contribute to the protection of little willow flycatcher habitat in forested and nonforested wetlands. Even-aged forest management throughout the west-side planning units would continue to provide shrubby habitats in regenerating clearcuts and sapling stands. This habitat is guaranteed and substantially more than that provided under the No Action alternative.

Alternative C

The riparian conservation strategy and forest management in the west-side planning units should provide breeding, foraging, and resting habitat for the little willow flycatcher. Riparian buffers would be established as described in DEIS Chapter 2. Ecosystem restoration within the riparian buffer would try to maintain the natural mix of conifer and deciduous species. The ecological integrity of the riparian buffer, and the little willow flycatcher habitat contained therein, would be protected by additional wind buffers as described in DEIS Chapter 2. Wetland buffers would also contribute to the protection of little willow flycatcher habitat in forested and nonforested wetlands, especially with the 50-foot no-harvest area within the buffer. Even-aged forest management throughout the west-side planning units would continue to provide shrubby habitats in regenerating clearcuts and sapling stands. This habitat is guaranteed and substantially more than that provided under the No Action alternative.

OESF Alternative 1

Current management of the riparian ecosystem on the OESF would be expected to provide at least some breeding, foraging, and resting habitat of the little willow flycatcher. Similar to the HCP No Action alternative, this protection would be provided primarily through the protection of relatively narrow contiguous tracts of large sawtimber and old-growth forest as well as riparian associated vegetation that are expected to occur or develop within the system of protected riparian management zones and unstable slopes in the OESF. Timber management activity would be restricted in the mass-wasting buffer of the riparian management zones under this alternative. Although some habitat is provided under current management practices under DNR's FRP, which is greater than the Washington Forest Practices Rules, this protection is not guaranteed. If riparian and wetland buffers were to be applied according to Washington Forest Practices Rules, little willow flycatcher habitat would be substantially reduced under the OESF No Action alternative.

OESF Action Alternatives

Management of the riparian ecosystem on the OESF would be the same for both action alternatives. This strategy would be expected to provide substantial breeding, foraging, and resting habitat of the little willow flycatcher. Ecosystem protection under these alternatives is intended to be derived largely from management directed at maintaining and restoring riparian ecosystem function as well as older forest conditions across much of the managed uplands. Specific protection of the habitat for this species would occur primarily from the establishment of, and restriction of timber harvest activities in, mass-wasting buffers within riparian management zones (including unstable slope areas). Buffers on all streams and wetlands in the OESF (HCP Chapter IV, DEIS Chapter 2) would, on average, be substantially greater than under the OESF No Action alternative, thus ensuring habitat availability for the little willow flycatcher.

Purple Martin (*Progne subis*)

The purple martin breeds in western Washington (Rodrick and Milner 1991). Purple martins require cavities for nesting, and declines in purple martin populations have been attributed to a reduction in the number of snags across its breeding range (Erhlich et al. 1988). Historically, the species probably utilized cavities excavated by woodpeckers, but only a few such nests are known today (Rodrick and Milner 1991). Its preferred breeding habitat is open areas near water (Erhlich et al. 1988). The species is an aerial forager of insects, and uses all seral stages of riparian/wetland forest as foraging habitat (Brown 1985).

ALTERNATIVE A

Current management under Washington Forest Practices Rules and DNR's FRP policies may result in leaving snags suitable for purple martins. Snags are required to be left after timber harvest, however, there is no guarantee that they will be suitable. The current riparian strategy has resulted in buffers averaging 196 feet along Type 1 and 2 Waters, and 89 feet along Type 3 Waters. These buffers incur no management activity at present, so it is likely that they contain suitable snags and foraging areas for purple martins. Some of these waters, however, have received no buffers. Additional potential purple martin habitat would likely be available in protected spotted owl territories, but as the stands become unoccupied by spotted owls they would likely be harvested. As such, protection of purple martin habitat under the Alternative A owl strategy would be incidental and temporary.

ALTERNATIVE B

The riparian conservation strategy should provide breeding, foraging, and resting habitat for purple martins. Riparian buffers would be established as described in DEIS Chapter 2 and HCP Chapter IV. The ecological integrity of the riparian buffer, and the purple martin habitat contained therein, would be protected by wind buffers. Where there is at least a moderate potential for windthrow, Type 1 and 2 Waters, and Type 3 Waters greater than 5 feet wide, would be protected by an additional wind buffer. Management activities within the riparian buffer would be stratified to maintain or restore the quality of salmonid habitat. Buffers on nonforested wetlands would be greater than or equal to 100 feet, which would maintain the integrity of potential feeding sites. Areas managed for spotted owl breeding habitat would provide a target condition of at least 50 percent of the landscape measured within each WAU (HCP Chapter IV). This management is expected to result in the development of late-successional forest containing a variety of snags. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live trees and snags. Ecosystem restoration within the riparian buffer would try to maintain the natural mix of conifer and deciduous species. In addition, this alternative contains a special provision for protecting very large, old trees as part of the snag and green tree retention strategy (Appendix 3, Chapter IV, Section F). The additional snags and green trees would function as a source of current and future habitat for purple martins. These conservation measures are greater than under the No Action alternative because of the owl conservation strategy, guaranteed riparian buffers, the snag and green tree retention strategy, and the special provision to protect large, older trees which may function in the future as purple martin habitat.

ALTERNATIVE C

The riparian conservation strategy is similar to Alternative B and should provide breeding, foraging, and resting habitat for purple martins; riparian buffers would be wider on Type 5 Waters, and wind buffers would be on both sides of Type 1 through 3 Waters (DEIS Chapter 2). Buffers on nonforested wetlands would be greater than or equal to 100 feet, and include a 50-foot no-harvest area, which would maintain the integrity of potential feeding sites. Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2). This management is expected to result in the development of late-successional forest containing large snags. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large live trees and snags. In addition, this alternative contains the special provision for protecting very large, old trees as part of the snag and green tree retention strategy (DEIS Chapter 2). The additional snags and green trees would function as a source of current and future habitat for purple martins. These conservation measures are greater than under the No Action alternative because of the owl conservation strategy, guaranteed riparian buffers, the snag and green tree retention strategy, and the special provision to protect large, older trees which may function in the future as purple martin habitat.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES

The purple martin is not commonly found in the OESF. Thus, an assessment of the OESF No Action and action alternatives was not conducted.

Western Bluebird (*Sialia mexicana*)

The western bluebird breeds throughout Washington and is a year-round resident in western portions of the state (National Geographic Society 1987). Western bluebirds require cavities for nesting, and often nest in cavities excavated by woodpeckers (Rodrick and Milner 1991). Nests are found in open woodlands, burned areas with snags, and other open areas with scattered trees (Rodrick and Milner 1991; Erhlich et al. 1988). In western Washington, western bluebirds were found in the majority of all clearcuts where snags were present, and bluebird density was positively correlated with snag density (Schreiber and deCalesta 1992). The species forages on small invertebrates and berries. Prey are often captured by hawking from low perch.

ALTERNATIVE A

Current management under Washington Forest Practices Rules and DNR's FRP policies will provide at least three wildlife reserve trees (typically snags when available) for each acre of timber harvested. This target, and snags retained in the riparian buffers, would provide some breeding habitat for western bluebirds. Even-aged forest management throughout the west-side planning units will continue to provide openings suitable for foraging and resting habitat.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for western bluebird breeding and resting habitat where these areas occur in proximity to foraging habitats. In areas managed for spotted owl breeding habitat at least 50 percent of each WAU would be sub-mature forest or better which may be adequate for breeding habitat. The remainder of the landscape would be comprised of a matrix of different seral stage forests providing resting and foraging opportunities. Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would protect some snags suitable for western bluebirds. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, and on hillslopes with a high risk of mass wasting, should eventually result in forests with mature and old-growth characteristics, and snags of different size and decay class. In addition, the provision to retain three snags and five green trees per acre harvested would ensure that current and future snags are available in upland areas for use by western bluebirds. This protection is guaranteed and is substantially greater than under the No Action alternative.

ALTERNATIVE C
The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for western bluebird breeding and resting habitat where these areas occur in proximity to foraging habitats. Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2) which should provide suitable snags for the western bluebird. The remainder of the landscape would be comprised of a matrix of different seral stage forests providing a source of suitable resting and foraging sites. Most of the habitat in the riparian buffers and on unstable hillslopes would not be harvested, and some of these areas would contain snags of different sizes and decay classes providing additional potential habitat for the western bluebird. In addition, the provision to retain three snags and five green trees per acre harvested would ensure that current and future snags are available in upland areas for use by western bluebirds. This protection is guaranteed and is greater than under the No Action alternative.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES
The western bluebird is not commonly found in the OESF. Thus, an assessment of the OESF No Action and action alternatives was not conducted.

Band-tailed Pigeon (*Columbia fasciata*)
The band-tailed pigeon is a migratory, upland game bird in Washington that occurs west of the Cascade crest (Rodrick and Milner 1991). Concern for this species has been prompted by the population decline reflected in breeding bird surveys. Populations in Washington have exhibited the greatest decline (Braun 1994). Band-tails are found within the coniferous forest zone and are associated with mixed conifer-hardwood habitats (Larsen et al. in prep.). This species typically uses a stick platform in a conifer tree as a nest (Ehrlich et al. 1988; Braun 1994). During the nesting season, band-tailed pigeons are most common in low elevation forests (less than 1,000 feet) with various seral stages and openings that are well interspersed (Rodrick and Milner 1991). They feed upon plant foods including buds, flowers, and fruits of hardwood trees, shrubs, and herbaceous plants, but also feed on cultivated fruits and grains (Braun 1994). This species is dependent upon the availability of mineral sources (e.g., mineral springs, cattle salt blocks) for producing crop milk for juveniles (Braun 1994).

ALL ALTERNATIVES
Several forest management actions, which apparently would be employed in all three alternatives, have the potential to affect the band-tailed pigeon. Conversion of old forests to dense second growth stands could make formerly available mineral sources inaccessible or unsuitable for use. Projected herbicide treatments across 60,000-80,000 acres in the next decade could reduce available food sources of the band-tailed pigeon. In

addition, manual clearing of hardwood species will occur across 60,000-100,000 acres in the next decade. These actions would likely have negative effects upon populations of band-tailed pigeons.

Alternative A

Under Alternative A, much of the remaining old-growth forests will be retained within spotted owl circles, until such time as the owls move or abandon the site center. These forests may be important to band-tailed pigeons as nesting and foraging habitat, and as sites containing undisturbed mineral sources. Regenerating stands may not have undisturbed mineral sources that are accessible to band-tails. Band-tailed pigeons often use stands that are more open than many regenerating stands. Further, regenerated late-successional stands would not be distributed as widely as existing old-growth stands. Alternative A also provides no-harvest buffers that, if allowed to become late-successional stands, may support understory forage plants used by band-tailed pigeons. Although this alternative appears to offer the most support to the band-tailed pigeon, it is important to note that owl habitat may eventually be harvested, and current riparian and wetland management zones are not guaranteed.

Alternative B

Alternative B would convert some of the existing old-growth forests into regenerated younger stands. Old-growth forests probably provide a better combination of important resources (nest sites, undisturbed mineral sources, and food plants) to pigeons than regenerating forests. Under Alternative B, 50 percent of the WAUs would be managed for owl breeding habitat which would provide some late-successional forests, and likely protect some mineral sources. Nonforested wetlands would have 100-foot managed buffers, which should maintain, to some extent, the integrity of these wetlands. Some of these wetlands may provide a source of minerals for the band-tailed pigeon. Harvestable riparian and wetland buffers, under Alternative B, could benefit band-tails if allowed to support understory food plants. In addition, impacts to mineral springs would be reduced by designing management activities within 200 feet of mineral springs to retain food sources, restrict herbicide spraying, avoid disturbance, and address other conservation needs. These management activities would be designed in coordination with USFWS. The commitment to guaranteed riparian and wetlands buffers, the provision to conduct limited management activities near mineral springs, and maintenance of 50 percent owl habitat, likely would provide more habitat for band-tailed pigeons in the long term than would Alternative A.

Alternative C

The greater provision of designated late-successional forest (60 percent of WAUs) under this alternative than Alternative B should have a greater benefit for band-tails but its clumped distribution around federal reserves would reduce its interspersion with other habitats. This alternative also provides larger riparian and wetland buffers than Alternative B, which should contribute more to band-tailed pigeon life requisites than Alternative B, and thus Alternative A. However, proposed restoration in these buffers may not be conducive to forage plant production. Nonforested wetlands would have 100-foot managed buffers with a 50-foot no-harvest area, which should maintain the integrity of these wetlands. Some of these wetlands may provide a source of minerals for the band-tailed pigeon. Harvestable riparian and wetland buffers, under Alternative C, could benefit band-tails if allowed to support understory food plants. In addition, impacts to mineral springs would be reduced by designing management activities within 200 feet of mineral springs to retain food sources, restrict herbicide spraying, avoid disturbance, and address other conservation needs. These management activities would be designed in coordination with USFWS. The commitment to guaranteed riparian and wetlands buffers, the provision to conduct limited management activities near mineral springs, and maintenance of 60 percent owl habitat likely would provide more habitat for band-tailed pigeons in the long term than would Alternative A.

OESF ALTERNATIVE 1
This alternative is similar to Alternative A above, although the widths of riparian buffers under current practices are different (DEIS Chapter 2). These differences are not substantial, and the effects on band-tailed pigeons are likely the same as Alternative A.

OESF ALTERNATIVE 2
The unzoned forest alternative would provide a wide distribution of late-successional forests across the planning area; 50 percent of the owl habitat being developed and/or maintained. While this distribution would be beneficial to band-tails, some existing old growth may be converted to younger stands. Existing old growth may provide higher quality habitat (greater food and undisturbed mineral source availability) than regenerated late-successional forests. Harvestable riparian and wetland buffers, substantially wider than in Alternative 1, would provide additional late-successional forest characteristics and could support understory forage plants for band-tail pigeons after harvest. The provision for mineral spring protection described in Alternative B would be the same under this alternative. The guarantees of the riparian and wetland buffers, the provision to conduct limited management activity near mineral springs, as well as the distribution of owl habitat throughout the OESF, would provide more band-tailed pigeon habitat than Alternative 1.

OESF ALTERNATIVE 3
The zoned forest alternative provides late-successional forest that will be clumped in zones near federal land reserves. This habitat configuration will limit older forest availability for band-tailed pigeons as existing old-growth forests are harvested. Habitat would be concentrated and not well distributed. Riparian and wetland provisions in this alternative are the same as Alternative 2, as well as the provision for mineral spring protection described in Alternative B, and would provide similar benefits to band-tailed pigeons. The amount of owl habitat would likely be less than what is currently available under Alternative 1, but protection of mineral springs would likely provide more habitat in the long term than under Alternative 1..

Mammals
Fifteen species of mammals that occur or may occur in the west-side HCP planning units are considered high priority species. Three species are federally listed, one is state listed, and nine are federal species of concern (61 Fed. Reg. 7457 (1996); USFWS (1996); WDFW 1995b). An analysis of the state-listed western gray squirrel and the eight federal candidate species of concern as well as 2 additional priority bat species is provided below.

Myotis Bats

The Yuma myotis (*Myotis yumanensis*), long-eared myotis (*M. evotis*) and long-legged myotis (*M. volans*) are common inhabitants throughout Washington. Although the fringed myotis (*M. thysanodes*) and small-footed myotis (*M. ciliolabrum*) are primarily east-side inhabitants, they are addressed here because occurrences west of the Cascades have been documented (C. Madrona 1995a, 1995b), and the habitats they utilize are similar to those of the other myotis species.

In Washington State, myotis species were detected 2.7 to 5.7 times more often in old-growth forests (greater than 200 years old) than in young forests (40-75 years old) (Christy and West 1993). Feeding rates of myotis bats were found to be 10 times greater over water than in the forest interior (Christy and West 1993). One inference drawn from this result is that the species depends on old-growth forests for roost sites rather than prey base. Standard recommendations for conservation (Christy and West 1993) include preserving roost sites and foraging areas, and prevention of disturbance by humans (Sheffield et al. 1992). Since these species utilize similar habitats, the assessment of the protection provided their habitats has been combined.

Yuma Myotis

The Yuma myotis uses nearly all habitats as long as open water is nearby (Barbour and Davis 1969). It is found in a variety of habitats such as coastal forests, Douglas-fir forests, and arid grasslands (Nagorsen and Brigham 1993). It is closely associated with water (Maser et al. 1981) -- 61 percent of foraging time is spent over water (Brigham et al. 1992). Other foraging habitats include grass, shrub, and open sapling stages of hardwood, and coniferous forests as well as hardwood and coniferous wetlands (Brown 1985). Breeding habitats (maternity colonies) are frequently located in caves and mines as well as under bridges and in buildings (Barbour and Davis 1969; Brown 1985). This species is known to use snags in old-growth forests for breeding sites. The Yuma myotis may use buildings and rock crevices (Nagorsen and Brigham 1993), and cavities in snags as day roosts.

Long-eared Myotis

The long-eared myotis is found in a variety of habitats such as mature and immature conifer, alder/salmonberry, and arid grasslands (Maser et al. 1981; Nagorsen and Brigham 1993). Foraging habitat for this species includes all seral stages, but there is a preference for mature and old-growth forest (Brown 1985). The long-eared myotis may use buildings or slabs of loose bark attached to trees as day roosts (Maser et al. 1981). There are also records of the species roosting in caves and rock fissures (Nagorsen and Brigham 1993). Roosting and breeding sites are often located in old-growth forests. Maternity colonies of 12 to 30 individuals have been found in buildings and hollow trees (Maser et al. 1981).

Long-legged Myotis

The long-legged myotis is found in a variety of habitats such as mature and immature conifer, alder/salmonberry, and arid range lands (Maser et al. 1981; Nagorsen and Brigham 1993). Foraging habitat for this species includes all seral stages, but there is a preference for young forest (Brown 1985). Roosts are situated in buildings, crevices in rock cliffs, fissures in the ground, and under the bark of trees (Nagorsen and Brigham 1993). The long-legged myotis may use buildings, fissures in the ground, and bark attached to trees for maternity colonies (Nagorsen and Brigham 1993). Roosting and breeding sites are often located in old-growth forests. Maternity colonies typically contain several hundred individuals (Maser et al. 1981).

Fringed Myotis

The fringed myotis is typically found in deserts, arid grasslands, and arid forests (Nagorsen and Brigham 1993), but it has also been found in immature coniferous forests of coastal Oregon and in the western Cascades (Maser et al. 1981; C. Madrona 1995a). The species shows a preference for foraging in areas of grass-forb and shrub (Brown 1985). Roosting sites include buildings, mines, caves, and rock crevices (Nagorsen and Brigham 1993). Maternity colonies have been discovered in caves and buildings (Nagorsen and Brigham 1993).

Small-footed Myotis

The small-footed myotis is typically found near cliffs and rock outcrops in arid valleys and badlands (Nagorsen and Brigham 1993), but it has also been found in the western Cascades (C. Madrona 1995b). The species forages over rocky bluffs and seldom over water. Roosting sites include cliffs, boulders, and talus slopes (Nagorsen and Brigham 1993). Maternity colonies occupy similar sites (Nagorsen and Brigham 1993).

ALTERNATIVE A

Under current management, owl habitat retained in owl circles would contain trees with surface structures (bark) and snags that may function as roost sites. Protection of snags in the riparian buffers and those required by Washington Forest Practices Rules would also be expected to provide some habitat suitable for bat roosts. Feeding areas such as open clearcuts and edges would continue to be available. Nonforested wetland buffers have averaged 86 feet in the past which likely maintains the integrity of this habitat as foraging areas. If this protection were to continue, some bat foraging habitat would continue to be available. Since no direct protection of caves and or talus is provided, protection of these bat habitat types would be minimal.

ALTERNATIVE B

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for myotis bat breeding, foraging, and resting habitat. In areas managed for spotted owl breeding habitat, at least 50 percent of each WAU would be sub-mature forest or better, providing a source of potential roosting habitat. Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would provide various combinations of riparian and wind buffers depending on the stream type that would likely protect breeding and roosting habitat (HCP Chapter IV, DEIS Chapter 2). Management within the riparian buffer, and on hillslopes with a high risk of mass wasting, in particular in the no-harvest and minimal-harvest areas, should eventually result in forests containing suitable trees and snags for roosts. Wetland buffers on nonforested wetlands would likely maintain the integrity of this habitat, thereby providing foraging opportunities. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large trees and snags. In addition, talus fields, cliffs, and caves would be protected as described in HCP

Chapter IV, Section F and Appendix 3, Chapter IV, Section F, in this document. Live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies would not be harvested. Under Alternative B, very large long-lived trees would be retained, as part of the snag and green tree retention strategy, providing potential suitable snags for maternal roosts in the future. The snags protected and green trees provided in this latter conservation measure would ensure that potential roost sites would be available now and in the future. In addition, there is a provision directed toward preventing human disturbance to bat caves by keeping cave locations confidential. These conservation measures are substantially greater than what occurs under the No Action alternative.

ALTERNATIVE C

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for myotis bat breeding, foraging, and resting habitat. Areas managed for spotted owl breeding habitat would provide a target condition of at least 60 percent of the landscape measured within each WAU (DEIS Chapter 2). Outside of the areas managed for spotted owl breeding habitat, the riparian strategy would provide various combinations of riparian and wind buffers depending on the stream type that would likely protect potential maternal and night roosts. Management within the riparian buffer, and on hillslopes with a high risk of mass wasting, in particular in the no-harvest and minimal harvest areas, should eventually result in forests containing suitable trees and snags for roosts. Wetland buffers on nonforested wetlands would likely maintain the integrity of this habitat, thereby providing foraging opportunities. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest containing large trees and snags. In addition, talus fields, cliffs, and caves would be protected as described in HCP Chapter IV, Section F and in this document, Appendix 3, Chapter IV, Section F, and live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies would not be harvested. Under Alternative C, very large long-lived trees would also be retained, as part of the snag and green tree retention strategy, providing potential suitable snags for maternal roosts in the future. The snags protected and green trees provided in this latter conservation measure would ensure that potential roost sites would be available now and in the future. In addition, there is a provision directed toward preventing human disturbance to bat caves by keeping cave locations confidential. These conservation measures are substantially greater than what occurs under the No Action alternative.

OESF ALTERNATIVE 1

Under current management, owl habitat retained in owl circles would contain trees with surface structures (bark) and snags that may function as roost sites. Protection of snags in the riparian buffers and those required by Washington Forest Practices Rules would also be expected to provide some habitat suitable for bat roosts. Feeding areas such as open clearcuts and edges would continue to be available. Nonforested wetland buffers have averaged 86 feet in the past which likely maintains the integrity of this habitat as foraging areas. If this protection were to continue, some bat foraging habitat would continue to be available. Riparian buffers have averaged from 95 feet on Type 4 Waters to 145 feet on Type 1 Waters, in which no timber management activity has been allowed, and likely provides a source of large trees and snags that may function as bat roosts. However, some of these waters received no buffers, and since no direct protection of caves and or talus is provided, protection of these bat habitat types would be minimal.

OESF ALTERNATIVE 2

Under this alternative, each landscape planning unit would have a 40 percent threshold amount of nesting, roosting and foraging habitat for spotted owls. The remainder of the landscape planning unit would be comprised of a matrix of different seral stage forests providing edge and open spaces for foraging. This strategy and the riparian strategy specifying stream buffers averaging 150 feet along Type 1 and 2 Waters, and 100 feet along Type 3 and 4 Waters, and nonforested wetlands with 100-foot buffers would likely ensure that an adequate amount of suitable snags and large trees are available to function as bat habitat. Some management may occur in the outer portion of the stream buffers and in the wetland buffers around forested wetlands, however, these strategies would likely retain some suitable snags for bats and contribute protection of potential foraging areas. In addition, talus fields, cliffs, and caves would be protected as described in HCP Chapter IV, Section F and Appendix 3, Chapter IV, Section F in this document, as well as very large long-lived trees. Live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies would not be harvested, and potential future roosts would be available through the snag and green tree retention strategy described in Alternative B. In addition, there is a provision directed toward preventing human disturbance to bat caves by keeping cave locations confidential. These conservation measures are greater than what occurs under OESF Alternative 1.

OESF ALTERNATIVE 3

Under this alternative, management would concentrate on areas with a likely potential to support spotted owl pairs, and several special pair areas (DEIS Chapter 2). Annual range areas would be managed so that at least 40 percent of the area would be in young-forest marginal or better habitat. The remainder of the area would be comprised of a matrix of different seral stage forests providing edge and open spaces for foraging. This strategy and the riparian strategy specifying stream buffers averaging 150 feet along Type 1 and 2 Waters, and 100 feet along Type 3 and 4 Waters, and nonforested wetlands with 100-foot buffers would likely ensure that an adequate amount of suitable snags and large trees are available to function as bat habitat. Some management may occur in the outer portion of the stream buffers and in the wetland buffers around forested wetlands, however, these strategies would likely retain some suitable snags for bats and contribute protection of potential foraging areas. In addition, talus fields, cliffs, and caves would be protected as described in HCP Chapter IV, as well as very large long-lived trees. Live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies would not be harvested. In addition, there is a provision directed toward preventing human disturbance to bat caves by keeping cave locations confidential. These conservation measures are greater than what occurs under OESF Alternative 1.

Townsend's Big-eared Bat (*Plecotus townsendii*)

The Townsend's big-eared bat has been documented in Washington in Yakima, Skamania, Klickitat, and Whatcom counties, along with several other east-side counties (Perkins 1990). There are no confirmed breeding sites for this species on the western

Olympic Peninsula. The presence of suitable undisturbed roost, maternity, and hibernaculum sites is the most important habitat component dictating the presence of this species (Perkins and Levesque 1987; Marshall 1992a). Big-eared bats use caves, buildings, mines, and the undersides of bridges with appropriate temperature and humidity for breeding (maternity colonies) and resting/roosting (hibernaculum) (Marshall 1992a). This species can occur in nearly any forest type as long as suitable breeding and resting/roosting habitat, such as nursery and hibernaculum sites, are present. Townsend's big-eared bat prefers to forage in mid-seral stage coniferous forests.

ALTERNATIVE A
Under current management, feeding areas such as early and mid-seral-stage forests would continue to be available. However, since this bat species roosts almost exclusively in caves and mines, and no direct protection of caves is provided, protection of big-eared bat breeding and roosting habitat would be minimal.

ALTERNATIVE B
Under this alternative, the combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for big-eared bat foraging habitat. Protection of breeding and roosting habitat of the big-eared bat would be provided by the conservation measures directed toward caves. Under this alternative, a 250-foot buffer would be established around cave entrances, and 100-foot buffer around passages that may be disturbed by surface activities. In addition, there is a provision directed toward preventing human disturbance to bat caves by keeping cave locations confidential. These conservation measures are greater than what occurs under Alternative A.

ALTERNATIVE C
Under this alternative, the combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for big-eared bat foraging habitat. Protection of breeding and roosting habitat of the big-eared bat would be provided by the conservation measures directed toward caves, which are the same as under Alternative B. These conservation measures are greater than what occurs under Alternative A.

OESF ALTERNATIVE 1
There are no caves known to exist in the OESF, however, under current management, feeding areas such as early and mid-seral-stage forests would continue to be available for use by big-eared bats, if present. However, since this bat species roosts almost exclusively in caves and mines, and no direct protection of caves is provided, protection of big-eared bat breeding and roosting habitat would be minimal.

OESF ACTION ALTERNATIVES
Under either action alternative, the combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for big-eared bat foraging habitat, if they are present. Although no caves are currently known to exist in the OESF, any caves discovered would receive the same protection as described in Alternatives B and C above. This protection would be adequate to protect big-eared bat breeding and roosting habitat, and would be greater than what occurs under the OESF No Action alternative.

Spotted Bat (*Euderma maculatum*)
The spotted bat had not been documented in Washington prior to 1991 (WDFW 1994a). Documented locations occur in Douglas, Grant, and Okanogan Counties of eastern Washington at elevations between 1,148 and 2,788 feet (350-850 meters) (Sarrell and McGuinness 1993). They potentially occur in the Chelan, Klickitat, and Yakima planning units, although this speculation needs to be confirmed (M. Perkins, J. M. Perkins-Consultants, Portland, OR, pers. commun., 1994). Spotted bat roosting habitat includes remote, tall, vertical rock faces (Sarrell and McGuinness 1993). Foraging habitat for this species includes areas over cliffs, talus, sagebrush, sparse ponderosa pine/bunchgrass communities, and riparian/wetland habitats (Sarrell and McGuinness 1993). Information on breeding habitat in Washington is not available and it is unknown whether spotted bats hibernate in Washington or migrate elsewhere. Since no information is available describing the breeding habitat of the spotted bat in Washington, assessment of the management options will be restricted to the foraging and roosting habitats for this species.

ALTERNATIVE A
Current management activity for the spotted owl under the No Action alternative is expected to provide no guaranteed protection of roosting or foraging habitat for the spotted bat. Roosting and foraging habitats as described above (excluding sagebrush communities) may be encompassed within the suitable owl habitat maintained within owl circles, however, these habitats would only be protected incidentally.

ALTERNATIVE B
Given that the spotted bat in Washington occurs exclusively east of the Cascade mountains, only the spotted owl strategies designed for the east-side planning units have the potential to protect the roosting and foraging habitat for this species. In areas managed for spotted owl breeding habitat at least 50 percent of each WAU would be sub-mature forest or better. Undisturbed older forest that encompasses cliffs would provide some protection from human disturbance and maintain roosting habitat. The spotted owl management strategy under this alternative would likely protect some foraging habitat as described above (excluding sagebrush communities), encompassed within the suitable owl habitat maintained in protected designated NRF management areas. This protection would be marginally better than that provided under the No Action alternative because it would protect larger areas and is more long term.

ALTERNATIVE C
The spotted owl strategies designed for the east-side planning units have the potential to protect the roosting and foraging habitat for this species. In areas managed for spotted owl breeding habitat at least 60 percent of each WAU would be sub-mature forest or better. Undisturbed older forest that encompasses cliffs would provide some protection from human disturbance and maintain roosting habitat. The spotted owl management strategy under this alternative would likely protect some foraging habitat as described above (excluding sagebrush communities), encompassed within the suitable owl habitat maintained in protected designated NRF management areas. This protection would be marginally better than that provided under the No Action alternative because it would protect larger areas and is more long term.

Western Gray Squirrel (*Sciurus griseus*)
The western gray squirrel's distribution in Washington is closely tied to that of Oregon white oak (WDW 1993e). Three habitats in three distinct regions of Washington support western gray squirrels: (1) white oak/Douglas-fir surrounding prairies in the south Puget area; (2) oak/ponderosa pine mixed forests along the Columbia River; and, (3) grand fir/Douglas-fir forests in Chelan and Okanogan Counties (WDW 1993e). Breeding, foraging and resting habitats for this species occur in mid- to late-successional forests, where intertwined canopies are required to allow arboreal movement of these squirrels. Nesting occurs in trees that are 8-23 inches dbh (WDW 1993e).

ALTERNATIVE A
Current management activities in DNR-managed forests do not include harvest of oak woodlands. Where these woodlands provide habitat for the western gray squirrel, the habitat would be retained as a consequence of this policy. However, it is not guaranteed. Timber management activities are conducted in Douglas-fir/ponderosa pine forests characteristic of east-side owl habitat, which may contain habitat for the western gray squirrel. Under WAC 222-16-080 of the Washington Forest Practices Rules, the Forest Practices Board would adopt rules pertaining to management activities within the vicinity of a known individual occurrence, documented by WDFW, of a western gray squirrel, or that occur within an "important western gray squirrel landscape." Other than this regulation, there are no specific provisions in current DNR forest management policies for protection of this species, so harvest activities in the Douglas-fir/ponderosa pine forests could occur and may impact this species.

ALTERNATIVE B
The riparian conservation strategy is expected to guarantee some protection of the breeding, foraging, and resting habitat of the western gray squirrel. No harvest would occur on hillslopes with a high risk of mass wasting, and some oak forest would exist within or immediately below unstable areas. Riparian management zones along Type 1, 2, 3, and 4 Waters may also encompass some oak forest. This alternative would still be subject to WAC 222-16-080 of the Washington Forest Practices Rules. These rules are expected to provide further protection of the species' critical wildlife habitat. This alternative has a special provision to protect Oregon white oak woodlands (HCP Chapter IV and DEIS Chapter 2). This would provide protection for pure white oak stands, and for some ponderosa pine stands where white oak is a significant component. This conservation measure includes retention of all very large dominant oaks, and maintaining 25 to 50 percent canopy cover in areas where partial harvest is conducted. These forests occur in the Columbia Gorge, and on the east slope of the southern Washington Cascades. Protecting these forests would also ensure that western gray squirrels in these areas would be protected. This protection is greater than that provided under the No Action alternative.

ALTERNATIVE C
The protection and conservation measures under this alternative that would have an effect on the western gray squirrel are similar to Alternative B, except riparian buffers would be wider. Alternative C also contains the provision for protection of Oregon white oak woodlands (DEIS Chapter 2). This protection is similar to Alternative B and is greater than that provided under the No Action alternative.

OESF Alternative 1 and Action Alternatives
Gray squirrels are not known to occur on the Olympic Peninsula and are unlikely to occur in the future. Therefore, an analysis of OESF alternatives is unnecessary.

Pacific Fisher (*Martes pennanti pacifica*)
The Pacific fisher prefers mature and old-growth coniferous forests, and uses riparian areas disproportionately more than their occurrence (Powell and Zielinski 1994). The species avoids nonforested areas and forest stands with low canopy closure (Powell and Zielinski 1994), however, second-growth forests with good cover may also be used (Rodrick and Milner 1991). Fishers are associated with low- to mid-elevation forests, and it is thought that fishers avoid high elevations because they are poorly adapted to deep snowpacks (USDA and USDI 1994a). The current range of fishers in Washington includes the Olympic Mountains and the northern Cascade Range. In the past 40 years, most sightings of fishers in the Olympics and the west slope of the Cascades have been at elevations less than 3,300 feet (1000 meters) (Aubry and Houston 1992). Fishers require habitat with large hollow snags or trees which are used as maternity dens. Fishers prey on a variety of small to medium-sized mammals and birds and also feed on carrion. The structural complexity of older forests results in dense prey populations, and provides denning and resting sites for fishers (Powell and Zielinski 1994). Trapping, with logging, has had a major impact on fisher populations and, because fishers are easily trapped, where populations are low they can be jeopardized by the trapping of other furbearers (Powell and Zielinski 1994).

Alternative A
Current management would provide little or no protection of fisher habitat except where it coincides with spotted owl territories. Some fisher habitat may be provided in riparian or mass-wasting buffers that could function as travel corridors between larger blocks of older contiguous habitat, if current practices for wide no-harvest buffers were to continue. These areas may also be utilized as a prey source. Some downed logs and snags would be available in the riparian buffers, and across the landscape as a result of adherence to Washington Forest Practices Rules. The long-term availability of owl habitat, and the riparian and wetland buffers are not guaranteed, but under current policies and practices, some fisher habitat would be available under this alternative.

Alternative B
The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for fisher breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest, as well as closed canopy forests of different seral stages. In areas managed for spotted owl breeding habitat, at least 50 percent of the NRF management areas in each WAU would be sub-mature or higher quality habitat. The high quality habitat would have old-growth forest characteristics which should provide some large trees, snags and downed logs to function as fisher habitat. In total, 40-42 percent of the area managed for spotted owl breeding habitat would be sub-mature to old-growth forest. In the west-side planning units, the spotted owl strategy designates 117,000 acres to be managed as spotted owl dispersal habitat. At least 50 percent of the Dispersal management area in each WAU would meet the minimum specifications for spotted owl

dispersal habitat (HCP Chapter IV). The purpose of dispersal habitat is to support the movement of juvenile spotted owls between sub-populations on federal reserves, and it is likely the availability of this habitat may enhance the survival of dispersing juvenile fishers. Most of the owl habitat provided on DNR-managed lands would be at elevations less than 3,300 feet (1000 meters), and, thus, would likely benefit fishers. Large, old trees would be specified for retention as part of the snag and leave tree strategy of this alternative that provides three snags and five green trees per acre harvested. Preference would be shown for hard snags with bark and snags at least 40 feet high. One of the green trees must be from the largest diameter size class in the harvested unit. These provisions would protect current potential fisher den sites as well as provide potential future den sites. Under Alternative B, DNR would conduct no activity that would appreciably reduce the likelikhood of denning success within 0.5 mile of a known active fisher den between February 1 and July 31 in areas managed for spotted owl breeding habitat. Road closures on DNR-managed lands would occur, consistent with cost-effective forest management and the policy set forth in the Forest Resource Plan. Under this policy, DNR would cooperate with the Services to restrict road access to protect sensitive wildlife habitat. Although this policy is the same as under Alternative A, additional conservation measures for fishers would be greater under Alternative B than under Alternative A.

ALTERNATIVE C

The combination of the riparian and spotted owl conservation strategies should provide forest conditions suitable for fisher breeding, foraging, and resting habitat. In concert, these strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest. In areas managed for spotted owl breeding habitat, at least 60 percent of the NRF management areas in each WAU would be sub-mature or higher quality habitat. The high quality habitat would have old-growth forest characteristics which should provide some large trees, snags and downed logs to function as fisher habitat. Forest management would create a range of habitat types from grass-forb to late-successional forest which should provide habitat suitable for foraging and den sites. Most of the owl habitat provided on DNR-managed lands would be at elevations less than 3,300 feet (1000 meters), and, thus, would likely benefit fishers. Alternative C provides the same snag and green tree retention, seasonal den site protection, and road management plan as Alternative B, thus, the protection would be the same. The additional conservation measures for fishers would be greater under Alternative C than under Alternative A.

OESF ALTERNATIVE 1

Current management would provide some protection of fisher habitat where it coincides with owl territories, in the riparian buffers, and in the no-harvest mass-wasting buffers. The buffered areas could function as travel corridors between larger blocks of older contiguous habitat in spotted owl territories and on adjacent federal lands, and as sources of prey availability. Some downed logs and snags would be available in the riparian buffers, and across the landscape as a result of adherence to Washington Forest Practices Rules. This protection of habitat is not guaranteed and would be minimal.

OESF Alternative 2

Under this alternative, each landscape planning unit would have a 40 percent threshold amount of nesting, roosting and foraging habitat for the spotted owl. The remainder of the landscape planning unit would be comprised of a matrix of different seral stage forests, including owl dispersal habitat, some of which would function as foraging areas. This strategy and the riparian strategy specifiying stream buffers averaging 150 feet along Type 1 and 2 Waters, and 100 feet along Type 3 and 4 Waters, and wetland buffers of 100 feet on nonforested wetlands would likely ensure that an adequate amount of downed logs and snags suitable for fisher den sites are available. Some management may occur in the outer portion of the stream buffers and in the wetland buffers around forested wetlands, however, these strategies would likely retain some suitable snags for fishers and contribute to protection of potential foraging areas. Special provisions for the retention of large, old trees, snags and green trees, and protection of known den sites would be the same under this alternative as in Alternatives B and C above. This protection and maintenance of potential fisher habitat is guaranteed and substantially greater than that provided under OESF Alternative 1.

OESF Alternative 3

Under this alternative, management would concentrate on areas with a likely potential to support owl pairs, and several special pair areas (DEIS Chapter 2). Annual range areas would be managed so that at least 40 percent of the area would be in young-forest marginal or better habitat. The remainder of the landscape planning unit would be comprised of a matrix of different seral-stage forests, including owl dispersal habitat, some of which would function as foraging areas. This strategy, and the riparian strategy described in Alternative 2 above, would likely ensure that an adequate amount of downed logs and snags suitable for fisher den sites are available in the owl concentration areas. There would not be a distribution of owl habitat throughout the OESF and therefore, fisher habitat outside the riparian areas would be patchy. Some management may occur in the outer portion of the stream buffers and in the wetland buffers around forested wetlands, however, these strategies would likely retain some suitable snags for fishers and contribute to protection of potential foraging areas. Special provisions for the retention of large, old trees, snags and green trees, and protection of known den sites, would be the same under this alternative as in Alternatives B and C above. This protection and maintenance of potential fisher habitat is guaranteed and substantially greater than that provided under OESF Alternative 1.

California Wolverine (*Gulo gulo luteus*)

The California wolverine is a wide-ranging species that utilizes a wide variety of habitat types, and is generally found in remote montane forest areas (Butts 1992). Wolverine habitat is probably best defined in terms of adequate year-round food supplies in large, sparsely inhabited wilderness, rather than in terms of plant associations (Banci 1994). Wolverines avoid clearcuts, although they will travel through them if necessary. Denning and resting habitats are usually in areas with an abundance of fallen logs, talus slopes, and deep snow; however, no specific habitat associations can be determined at this time (Hatler 1989). Wolverines may use managed lands as long as the land is adjacent to a refugia such as a wilderness area (Banci 1994). A primary component of suitable habitat for this species is a low level of human activity.

ALTERNATIVE A

Current management would provide little or no protection of wolverine habitat except where it coincides with owl territories. Some wolverine habitat may be protected in riparian or mass-wasting buffers on higher Type 4 and 5 Waters, but this would be minimal. There are no specific measures of current management policies that provide protection from human disturbance should a wolverine den site be located on DNR-managed lands.

ALTERNATIVE B

There is very little montane forest on DNR-managed lands. However, some parcels of DNR-managed forest are positioned adjacent to federal wilderness areas and federal Late-Successional Reserves that may serve as refugia for wolverines. Therefore, it is possible that wolverines could now or in the future be present in DNR-managed forests. In areas managed for spotted owl breeding habitat at least 50 percent of each WAU would be sub-mature forest or better providing a source of potential wolverine habitat. The combination of the riparian and spotted owl conservation strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest that would provide forest conditions suitable for some wolverine breeding, foraging, and resting habitat. Forest management would create a range of habitat types from grass-forb to late-successional forest which should provide habitat suitable for foraging and densites. However, it is likely that wolverines would only utilize these areas at the higher elevations and where the largest tracts of land occur that remain undisturbed by human activity, and are adjacent to large undisturbed wilderness areas. Under Alternative B, DNR would conduct no activity within 0.5 mile of a known active wolverine den between January 1 and July 31 in areas managed for spotted owl breeding habitat that would appreciably reduce the likelihood of denning success. Road closures on DNR-managed lands would occur, consistent with cost-effective forest management and the policy set forth in the Forest Resource Plan. Under this policy, DNR would cooperate with the Services to restrict road access to protect sensitive wildlife habitat. Although this policy is the same as under the No Action alternative, additional conservation measures for wolverines would be greater under Alternative B than under Alternative A.

ALTERNATIVE C

In areas managed for spotted owl breeding habitat at least 60 percent of each WAU would be sub-mature forest or better, providing a source of potential wolverine den site habitat. The combination of the riparian and spotted owl conservation strategies should ensure the development of large contiguous landscapes of sub-mature to old-growth forest that would provide forest conditions suitable for some wolverine breeding, foraging, and resting habitat. Forest management would create a range of habitat types from grass-forb to late-successional forest which should provide habitat suitable for foraging and den sites. However, it is likely that wolverines would only utilize these areas at the higher elevations and where the largest tracts of land occur that remain undisturbed by human activity, and are adjacent to large undisturbed wilderness areas. Under Alternative C, DNR would conduct no activity within 0.5 mile of a known active wolverine den between January 1 and July 31 in areas managed for spotted owl breeding habitat that would appreciably reduce the likelihood of denning success. Road closures on DNR-managed lands would occur, consistent with cost-effective forest management and the policy set forth in the Forest Resource Plan. Under this policy, DNR would cooperate with the

Services to restrict road access to protect sensitive wildlife habitat. Although this policy is the same as under Alternative A, additional conservation measures for wolverines would be greater under Alternative C than under Alternative A.

OESF Alternative 1 and Action Alternatives

Wolverines are not known to occur on the Olympic Peninsula and are unlikely to occur in the future. Therefore, an analysis of OESF alternatives is unnecessary.

Lynx (*Lynx canadensis*)

Washington's lynx population is estimated to be between 96 and 191 individuals, with the population responding largely to snowshoe hare prey abundance (WDW 1993c, WDFW 1994a). The lynx in Washington is found at elevations above 3,300 feet (1,000 meters) (Brittell et al. 1989), ranging from Canada into northeast and north-central Washington, to east of the Cascade crest and through the Okanogan Highlands into northern Idaho (McCord and Cardoza 1990; WDW 1993c, WDFW 1994a). Recent sightings have been recorded throughout Washington and into Oregon, but few sightings have been confirmed, and it is uncertain if these represent breeding individuals (B. Naney, USFS, Okanogan, WA, pers. commun., 1994). Within the HCP planning area, the lynx may occur on DNR-managed lands in the Chelan Planning Unit. The lynx occurs in very remote areas, using extensive tracts of dense forests that are interspersed with rock outcrops, bogs, and thickets for breeding, foraging, and resting habitat (McCord and Cardoza 1990). They use a mosaic of forest types from early-successional to mature conifer and deciduous forests, as long as snowshoe hare are present, upon which they are almost totally dependent. Lynx forage in early-successional forest for prey, and den in mature forests. A primary component of suitable habitat for this species is a low level of human activity.

All Alternatives

The likelihood that lynx would occur on DNR-managed lands in the HCP area is small. The Chelan Planning Unit contains approximately 15-20 separately scattered sections of DNR-managed land, mostly between Mazama and Leavenworth. Under the current management for spotted owl territories, protection of lynx habitat would be incidental on DNR-managed lands in this area. The spotted owl strategies under each action alternative would provide adequate protection of lynx habitat on all or part of six sections of DNR-managed lands just north of Leavenworth, because these sections have been designated as NRF management areas. Any protection of the lynx's prey base in early seral-stage forests or potential den sites in mature forests would be incidental to protection of spotted owl circles, or the few sections of land designated as spotted owl NRF habitat under the action alternatives. While these differences in the amount of lynx habitat protection or species conservation measures are minimal, the action alternatives would be more beneficial to the lynx than the No Action alternative.

OESF Alternative 1 and Action Alternatives

Lynx are not known to occur on the Olympic Peninsula and are unlikely to occur in the future. Therefore, an analysis of OESF alternatives is unnecessary.

California Bighorn Sheep (*Ovis canadensis californiana*)
The California bighorn sheep has been reintroduced into the state over the last several decades. Based on available information, it is questionable whether the range of bighorn sheep extends into any of the HCP planning units. No sheep occur on the west side of the Cascade crest, and their elevational range varies locally. California bighorn sheep are known to occur along the Columbia River, about midway between Wenatchee and Chelan, along the Yakima River between Ellensburg and Yakima, and near Chinook and White Passes (R. Johnson, WDFW, Olympia, WA, pers. commun., 1994). This species is restricted to semi-open, precipitous terrain with rocky slopes, ridges, and cliffs or rugged canyons for breeding, foraging, and resting (Brown 1985). Bighorns prefer to forage on open slopes (Johnson 1983) and normally avoid thick forests (Lawson and Johnson 1982), although they occasionally use scattered ponderosa pine/Douglas-fir stands.

ALL ALTERNATIVES
No effect to California bighorn sheep is anticipated under any of the alternatives. The areas occupied by bighorn sheep east of the Cascade crest contain only scattered sections of DNR-managed land. Under both action alternatives, conservation strategies for DNR-managed lands east of the Cascade crest within the range of the spotted owl address only the spotted owl. The sections of DNR-managed lands that would be within the range of the spotted owl and the California bighorn sheep have been designated as lands without a spotted owl role (HCP Chapter IV). Therefore, there would be no difference between the alternatives with regard to effects on the California bighorn sheep.

OESF ALTERNATIVE 1 AND ACTION ALTERNATIVES
California bighorn sheep are not known to occur on the Olympic Peninsula and are unlikely to occur in the future. Therefore, an analysis of OESF alternatives is unnecessary.

4-451 4.5.3 Endangered, Threatened and Sensitive Plant Species

4-451 Vascular plants species that are listed by the federal government or are proposed for listing

4.5.3 Endangered, Threatened and Sensitive Plant Species

In general, the federally listed and proposed endangered and threatened plant taxa described below and in Tables 4.5.5 and 4.5.6 have very limited ranges and narrow habitat requirements and are restricted to very small areas. Because of these factors, it is anticipated that they can be effectively managed while meeting other land-management objectives. DNR maintains a database on these species, including both site-specific and species-specific information, that will be useful in locating and protecting known sites and potential habitat. However, no comprehensive inventories of these species exist for DNR-managed lands.

Vascular plant species that are listed by the federal government or are proposed for listing.

Table 4.5.5 lists those plant species that have been listed or are proposed for listing by the federal government. Brief statements about each species are provided below; additional information can be obtained from either the U.S. Fish and Wildlife Service Endangered Species office in Olympia or DNR's Natural Heritage Program.

***Arenaria paludicola*.** Swamp sandwort was historically known to occur in "swamps near Tacoma" but has not been seen or collected in Washington since the late 1800s. Reports from several other western Washington locations have been determined to be misidentifications. However, additional inventory in Washington is needed, primarily in wetlands within the Puget Lowlands. The only known extant site in the world is found in a brackish wetland in California. However, this species could occur in wetlands near the Pacific Coast, Willapa Bay, or Puget Sound. HCP Alternatives B and C and OESF Alternatives 2 and 3 would likely provide better protection of this species' habitat than would the No Action alternatives (HCP Alternative A and OESF Alternative 1) because of their better overall riparian and wetland protections.

***Castilleja levisecta*.** Golden paintbrush occurs from Thurston County northward to Vancouver Island. Historically it was also known to occur in the Willamette Valley in Oregon and in Clark County, Washington. The species is restricted to grasslands and areas dominated by a mixture of grasses and shrubs. Although this species occurs in grasslands, it could be affected by timber harvest through road building, yarding, or decking logs on adjacent grasslands. Where conifers invade *C. levisecta* habitat, the removal of trees is beneficial to the species. There are only 10 known sites with *C. levisecta* in the world, eight of which are in Washington and one of these is a DNR-managed Natural Area Preserve. All sites are quite small in area and are subject to a variety of threats, the most serious of which is the invasion by a mixture of Douglas-fir, Scot's broom, blackberries, and roses. It is not known to occur, nor is it expected to occur within the Olympic Experimental State Forest. There is little to no DNR-managed land adjacent to sites that harbor this species. The HCP alternatives are not expected to have any effect on this species.

***Howellia aquatilis*.** Water howellia is an aquatic annual generally found in vernal ponds or portions of ponds in which there is a significant seasonal draw down of the water level. All ponds known to contain this species have a deciduous tree component around their perimeters; most have conifers as well. The species is currently known to occur in Washington, Idaho, and Montana. In Washington, it has been found in Clark, Pierce and Spokane Counties. Historically it was also known to occur in Thurston and Mason Counties, as well as in Oregon and California. There has been no inventory of water howellia on DNR-managed lands, but if water howellia does occur in the planning area, then HCP Alternatives B and C would have fewer adverse effects on this species than the No Action alternative because these alternatives offer better overall wetlands protection and possible deferrals and protections for marbled murrelets.

Lomatium bradshawii. Bradshaw's lomatium was thought to be endemic to the Willamette Valley in Oregon until 1994, when it was discovered in Clark County, Washington. The one site in Washington is a seasonally flooded wetland dominated by grasses, sedges and rushes. As far as is now known within the HCP planning area, this species is restricted to wetlands in flood-plain habitats at low elevations in the Columbia Planning Unit. Although not known to occur on DNR-managed lands, some DNR-managed lands may provide potential habitat. HCP Alternatives B and C would likely provide better protection of this species' habitat than would the No Action alternative because of their better overall wetland and riparian protections. The OESF alternatives would have no effect, as the species is not known or expected to occur in the planning unit.

Sidalcea nelsoniana. Nelson's checkermallow was also thought to be restricted to Oregon until relatively recently. There are known sites in Cowlitz and Lewis Counties, Washington. These sites are in low elevation, moist meadows within the South Coast and Columbia HCP planning units. These sites may qualify as wetlands. There is a limited amount of DNR-managed land that contains suitable habitat. There is expected to be no difference between the various alternatives regarding their effects on this species due to its restriction to open, moist meadow habitats.

Federal candidate vascular plant species
There is one vascular plant species that is a candidate for listing (as of February 1996) under the federal ESA which is known to occur, or is reasonably suspected of occurring, within the HCP planning area. Additional information about this species can be obtained from DNR's Natural Heritage Program.

Sidalcea oregana* var. *calva. This taxon is restricted to the Chelan Planning Unit. It may occur on DNR-managed forest land. It can occur along small riparian areas and some of the sites would qualify as wetlands. Alternatives B and C can be expected to provide better protection than the No Action alternative due to the overall better riparian zone and wetlands protections. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Plant species of concern
There are a number of vascular plant taxa that are species of concern to the U.S. Fish and Wildlife Service (as of February 1996) which are known to occur, or are reasonably suspected of occurring, within the HCP planning area. Those species are listed below and in Table 4.5.6. Additional information about these species can be obtained from DNR's Natural Heritage Program.

Aster curtus. This taxon is restricted to grassland habitats in the lowlands of the Puget trough. It may occur in grasslands adjacent to DNR-managed forest land. It is not known nor expected to occur on the OESF. Because the plant is generally restricted to nonforested habitats, the HCP alternatives and the OESF alternatives are expected to have little effect on this species.

Astragalus pulsiferae* var. *suksdorfii. In Washington, this taxon is restricted to the Klickitat Planning Unit and occurs in somewhat open ponderosa pine stands with a relatively sparse understory. One known site of *A. pulsiferae* is on DNR-managed land designated as a Dispersal habitat management area. An alternative with higher harvest levels may provide better habitat protection for this taxon than an alternative with lower harvest levels. However, increased harvest levels may not be a recommended method for enhancing the habitat for this taxon; prescribed burns, or allowing natural fires to burn, would likely be a preferable method. The OESF alternatives would have no effect, as the taxon is not known or expected to occur on the OESF.

Botrychium ascendens. This taxon appears to have a fairly broad ecological amplitude and wide geographic range. However, there is insufficient information available regarding its response to timber harvest activities to evaluate the alternatives and their respective effects.

Calochortus longebarbatus* var. *longebarbatus. In Washington, this taxon is restricted to the Klickitat Planning Unit. It could occur on DNR-managed lands. It occurs primarily in open grasslands, but occasionally extends into open forest stands. Within the Yakama Indian Reservation, it can be found within harvested units and along roadway openings. Although this taxon could benefit from timber harvest in areas adjacent to meadow openings, it is anticipated that there is no effective difference between Alternatives B and C and the No Action alternative. The OESF alternatives will have no effect since the taxon is not known or expected to occur on the OESF.

Cimicifuga elata. This taxon occurs in DNR Dispersal management areas and potentially within NRF management areas. The taxon occurs within the North Coast, Straits, South Puget, South Coast, and Columbia planning units. HCP Alternatives B and C are expected to be more beneficial than the No Action alternative due to the lower timber harvest levels of the former in NRF and Dispersal management areas. The OESF alternatives would have no effect, since the taxon is not known or expected to occur on the OESF.

Corydalis aquae-gelidae. This taxon occurs primarily along Type 3 through 5 Waters, including small seeps, and is restricted to the Columbia Planning Unit. It could occur in on DNR-managed lands. HCP Alternatives B and C can be expected to provide better protection than the No Action alternative due to the overall better riparian zone protections.

Cypripedium fasciculatum. This taxon occurs within a variety of coniferous stands within the Klickitat, Yakima, and Chelan planning units. It could occur on DNR-managed lands. There is insufficient information available regarding this species' response to timber harvest activities to evaluate the alternatives and their respective effects.

Delphinium leucophaeum. This taxon is essentially a grassland species and is restricted to the South Coast Planning Unit. It could occur on DNR-managed lands. The HCP alternatives are expected to have no effect on this species. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Delphinium viridescens. This taxon is restricted to the Chelan and Yakima planning units. It may occur on DNR-managed lands. It can occur along small riparian areas and some of the sites would qualify as wetlands. HCP alternatives B and C can be expected to provide better protection than the No Action alternative due to the overall better riparian zone and wetlands protections. The OESF alternatives are expected to have no effect since the taxon is not known or expected to occur on the OESF.

Dodecatheon austrofrigidum. In Washington, this taxon is currently known to occur only in the Mt. Colonel Bob Wilderness Area of the Olympic National Forest. However, in Oregon it is known to occur in lower elevation riparian areas. HCP Alternatives B and C and the OESF action alternative are presumably better than the No Action alternative due to overall better riparian zone protections.

Erigeron howellii. In Washington, this taxon is restricted to the Columbia Planning Unit. It generally occurs in open areas. Canopy removal is not expected to have a negative impact, but ground-disturbing activity might. There is insufficient information to analyze which alternative would be the best for this species. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Erigeron oreganus. In Washington, this taxon is restricted to the Columbia Planning Unit. It occurs within owl dispersal habitat; however, it is found primarily on exposed rock. Canopy removal will not generally have a negative impact. There is probably little if any difference between HCP Alternatives B and C and the No Action alternative. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Filipendula occidentalis. In Washington, this taxon is restricted to river and creek banks in southwest Washington, in the Columbia and South Coast HCP planning units. Some DNR-managed land is relatively close to known sites for this taxon. It is expected that HCP Alternatives B and C could provide more protection than the No Action alternative because of their better riparian protections. The deferrals and protections for the marbled murrelet provided by HCP Alternatives B and C could also benefit this species. The OESF alternatives should have no effect since the taxon is not known or expected to occur on the OESF.

Hackelia venusta. This taxon is restricted to the Chelan Planning Unit. All known sites are on USFS lands. Some DNR-managed land occurs within the range of this species. Canopy removal would not have a negative impact and in fact might be beneficial. However, ground-disturbing activities could have a negative impact. At present, there is insufficient data to analyze the different alternatives and their potential effects on this species.

***Lathyrus torreyi*.** This taxon was thought to be extirpated from the state of Washington. The historic locations were scattered in Clark and Pierce Counties. The only extant site is at McChord Air Force Base, where it inhabits a mature conifer stand with an open understory. Timber management on DNR-managed lands under the HCP and OESF alternatives is unlikely to have an adverse effect.

***Lomatium suksdorfii*.** In Washington, this taxon is restricted to the Klickitat Planning Unit. It may occur on DNR-managed lands. It can occur within riparian areas, but it is not restricted to such areas. It occurs on slopes that may support scattered individual conifers, on the edges of conifer stands, or in stand openings. There is likely no difference between the alternatives for this species. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

***Lupinus sulphureus* var. *kincaidii*.** This taxon is essentially a grassland species and, in Washington, is restricted to the South Coast Planning Unit. It is unlikely to occur on DNR-managed lands. The HCP alternatives are expected to have no effect on this species. The OESF alternatives are expected to have no effect since the taxon is not known or expected to occur on the OESF.

***Meconella oregana*.** This taxon occurs in grasslands, sometimes adjacent to forested areas, although generally in somewhat savannah-like conditions. It is expected that there would be no difference between the HCP alternatives in terms of their effects on this taxon. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

***Mimulus jungermannioides*.** This taxon was historically known to occur in the Klickitat Planning Unit, but is currently thought to be extirpated from the state of Washington. It is restricted to seepage areas in exposed basalt. It is unlikely to occur on DNR-managed lands. The HCP alternatives are not expected to have any impact on this taxon. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

***Penstemon barrettiae*.** This taxon occurs primarily on exposed basalt in Washington and is known to occur only in the Klickitat Planning Unit. It may occur on DNR-managed lands. It may occur within riparian areas, although it is not restricted to riparian zones. It is expected that there would be no difference between the HCP alternatives. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

***Silene seelyi*.** This taxon is restricted to cracks in exposed rock in a small portion of the Chelan, and possibly the Yakima, planning units. Although it is not known to occur on DNR-managed lands, some DNR-managed lands are in close proximity to known locations for this species. The species is probably not affected to any great degree by canopy removal. It is expected that there are no differences between Alternatives B and C and the No Action alternative for this species.

Sisyrinchium sarmentosum. In Washington, this taxon is restricted to the Klickitat Planning Unit. It may occur on DNR-managed lands. It occurs in moist meadows and small forest openings, and it may occur within riparian and/or wetland areas. HCP Alternatives B and C can be expected to provide better protection than the No Action alternative due to the better riparian and wetland protections provided by the former. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Sullivantia oregana. In Washington, this taxon is known only to occur in the Columbia Planning Unit and occurs within waterfall spray zones and seepage areas. A site with *S. oregana* is located in a DNR-managed Natural Area Preserve, and other sites may occur in DNR-managed parcels adjacent to the preserve. HCP Alternatives B and C are expected to provide better protection than the No Action alternative because of their better riparian and wetland protections. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Trifolium thompsonii. This taxon is only known to occur in the Chelan Planning Unit. It is a grassland species, but it also occurs on the edge of forest stands. Fire is important in maintaining its habitat. This species is known to occur on DNR-managed lands. There is expected to be no difference between HCP Alternatives B and C and the No Action alternative. The OESF alternatives would have no effect since the taxon is not known or expected to occur on the OESF.

Table 4.5.5: Vascular plant taxa within the HCP planning area that are listed or proposed to be listed by the federal government

NHP = Natural Heritage Program; **POEX** = Possibly extinct or extirpated; **E** = Endangered; **T** = Threatened; **S** = Sensitive; **OESF** = Olympic Experimental State Forest; **WW** = Western Washington; **EW** = Eastern Washington within the range of the northern spotted owl.

Scientific Name	Federal Status	NHP Status	HCP Planning Areas	Geographic Area and/or Habitat
Arenaria paludicola[1]	Endangered	POEX	WW	"Swamps near Tacoma"
Castilleja levisecta	Proposed Threatened	E	WW	Puget trough grasslands
Howellia aquatilis	Threatened	E	WW	Pierce Co. southward; shallow ponds in lowland forested areas
Lomatium bradshawii	Endangered	*	WW	Clark Co. moist to wet meadows
Sidalcea nelsoniana	Threatened	E	WW	Lewis and Cowlitz Cos. moist meadows

[1] At the time of the most recent revision to *Endangered, Threateded and Sensitive Vascular Plants of Washington* (1994a), this species was not known to occur in Washington

Table 4.5.6: Vascular plant taxa within the HCP planning area that are a special concern to the U.S. Fish and Wildlife Service

NHP = Natural Heritage Program; **POEX** = Possibly extinct or extirpated; **E** = Endangered; **T** = Threatened; **S** = Sensitive; **OESF** = Olympic Experimental State Forest; **WW** = Western Washington; **EW** = Eastern Washington within the range of the northern spotted owl.

Scientific Name	NHP Status	HCP Planning Areas	Geographic Area and/or Habitat Comments
Abronia umbellata ssp. *acutalata**	POEX	WW, OESF	coastal dunes
Artemisia campestris ssp. *borealis* var. *wormskioldii**	E	EW, WW	Columbia River; shoreline
Aster curtus	S	WW	lowland prairies
Astragalus australis var. *olympicus**	T	W	NE Olympics; talus/scree
Astragalus pulsiferae var. *suksdorfii*	E	EW	Klickitat Co.; open forest
*Astragalus sinuatus**	E	EW	shrub-steppe
Botrychium ascendens	S	WW, EW	mid- to upper elevations; ridges/meadows
Calochortus longebarbatus var. *longebarbatus*	S	EW	Klickitat Co.; meadow/open forest
*Castilleja cryptantha**	S	WW	Mt. Rainier; moist meadows
Cimicifuga elata	T	WW	low elevation forest
Corydalis aquae-gelidae	T	WW	Skamania and Clark Cos.; seeps, creeks above 2,500 feet
Cypripedium fasciculatum	T	EW	forest
Delphinium leucophaeum	E	WW	SW Washington; lowland prairies
Delphinium viridescens	E	EW	Wenatchee Mtns.; meadows/moist areas

NHP = Natural Heritage Program; **POEX** = Possibly extinct or extirpated; **E** = Endangered; **T** = Threatened; **S** = Sensitive; **OESF** = Olympic Experimental State Forest; **WW** = Western Washington; **EW** = Eastern Washington within the range of the northern spotted owl.

Scientific Name	NHP Status	HCP Planning Areas	Geographic Area and/or Habitat Comments
Dodecatheon austrofrigidum	T	WW, OESF	southern Olympics
Erigeron howellii	T	WW	Columbia River Gorge; nonforested areas
Erigeron oreganus	T	WW	Columbia River Gorge; exposed basalt
Filipendula occidentalis	T	WW	SW Washington; riparian
Lathyrus torreyi	—**	WW	Clark, Peirce Cos.; conifer forest
Hackelia venusta	E	EW	Wenatchee National Forest; talus/scree
*Lomatium tuberosum**	T	EW	Yakima, Kittitas, Grant Cos.; talus
Lomatium suksdorfii	S	EW	Klickitat Co.; open slopes
Lupinus sulphureus var. *kincaidii*	E	WW	SW Washington; lowland prairies
Meconella oregana	T	WW, EW	Puget trough and Klickitat Co.; grassland and savannah
Mimulus jungermannioides	POEX	EW	Klickitat Co. seeps in Columbia River basalt
Penstemon barrettiae	T	EW, WW	Klickitat Co.; exposed basalt
*Petrophytum cinerascens**	T	EW	exposed rock
*Ranunculus reconditus**	T	EW	Klickitat Co.; steppe grassland
*Rorippa columbiae**	E	EW, WW	Columbia River; shoreline

NHP = Natural Heritage Program; **POEX** = Possibly extinct or extirpated; **E** = Endangered; **T** = Threatened; **S** = Sensitive; **OESF** = Olympic Experimental State Forest; **WW** = Western Washington; **EW** = Eastern Washington within the range of the northern spotted owl.			
Scientific Name	**NHP Status**	**HCP Planning Areas**	**Geographic Area and/or Habitat Comments**
Sidalcea oregana var. *calva*	E	EW	Wenatchee Mtns.; meadow/forest
Silene seelyi	T	EW	Wenatchee Mtns.; exposed rock
Sisyrinchium sarmentosum	T	WW	Skamania and Klickitat Cos.; meadows
Sullivantia oregana	T	WW	Columbia River Gorge; exposed rock
*Tauschia hooveri**	T	EW	shrub-steppe
Trifolium thompsonii	T	EW	Chelan and Douglas Cos.; grassland and forest edge

* These species are unlikely to be affected by proposed HCP management plans. See discussion below.
**The NHP status of *Lathyrus torreyi* was undetermined as of August 1996.

It was thought to be possibly extirpated until a population was discovered in McChord Air force Base in 1994.

Plant taxa of concern to the U.S. Fish and Wildlife Service in the HCP planning area that are highly unlikely to be affected

Several plant taxa have been determined to not occur within the planning area or do not occur on lands that will be affected (one way or the other) by management for spotted owls, marbled murrelets, or riparian and wetland areas. These taxa are identified below:

Abronia umbellata ssp. *acutalata.* This taxon is thought to be extirpated from the state of Washington. The historic locations were coastal sand dunes. Timber management under the HCP and OESF alternatives would have no effect.

Artemisia campestris ssp. *borealis* var. *wormskioldii*. This taxon is restricted to areas immediately adjacent to the Columbia River in Grant and Klickitat Counties. The areas do not support conifers and are far enough removed from DNR forest management that management activities are not likely to have any impact.

Astragalus australis var. *olympicus*. This taxon is restricted to relatively high elevations in the northeastern portion of the Olympic Peninsula. It is only known to occur in the Olympic National Park and Olympic National Forest.

Astragalus sinuatus. This taxon does not occur within the HCP planning area. It is restricted to a very small range east of the planning area in Chelan County.

Castilleja cryptantha. This taxon does not occur and is not expected to occur, on DNR-managed lands within the HCP planning area. It is restricted to subalpine and alpine meadows around the northern perimeter of Mt. Rainier.

Lomatium tuberosum. This taxon is restricted to talus slopes, mostly in nonforested areas, although there can be trees adjacent to the talus. Within the HCP planning area, this taxon is known only from the Yakima Planning Unit.

Petrophytum cinerascens. This taxon occurs just within the eastern edge of the Chelan Planning Unit and is restricted to rock outcrops adjacent to the Columbia River.

Poa unilateralis. This taxon is restricted to grass-dominated coastal bluffs in the South Coast Planning Unit. The taxon is not known, nor suspected, to occur on DNR-managed lands.

Ranunculus reconditus. This taxon is known to occur in Klickitat County, but not within the HCP planning area.

Rorippa columbiae. This taxon is restricted to the immediate shores of the Columbia River and islands in the Columbia River along the Hanford Reach and in Skamania County. No DNR-managed lands are known to harbor this species and timber management under the HCP is not expected to have an impact.

Tauschia hooveri. This taxon is restricted to lithosolic, nonforested habitats. It is known to occur on DNR-managed land. It occurs mostly east of the HCP planning area, although some sites are within the Yakima and perhaps the Klickitat planning units.