D. Riparian Conservation Strategy for the Five West-side Planning Units

Under this HCP, riparian conservation strategies shall be implemented in the five west-side planning units and the Olympic Experimental State Forest. The riparian conservation strategy for the Olympic Experimental State Forest is different than that to be implemented in the five west-side planning units because:

(1) in the Olympic Experimental State Forest, the emphasis on research and the systematic application of knowledge gained will likely lead to refinements and revisions in the riparian conservation strategy over time, and

(2) the climatic, geological, and physiographic characteristics of the western Olympic Peninsula present special problems for forest management around riparian areas.

See Section E of this chapter for a description of the Olympic Experimental State Forest riparian conservation strategy.

Neither riparian conservation strategy will be applied in the east-side planning units. But riparian management there will continue to follow state Forest Practices regulations and policies of the Board of Natural Resources.

DNR will continue to participate in watershed analysis according to state Forest Practices Rules (WFPB 1994). If watershed analysis indicates that public resources require a greater level of protection than that specified by the HCP, the prescriptions developed through watershed analysis to provide this additional protection shall be implemented. As of the writing of this HCP watershed analysis does not address wildlife, and one of the objectives of the riparian conservation strategy, as discussed below, is the conservation of riparian obligate wildlife. In order to continue to meet this conservation objective, all components of the strategy shall still apply to DNR-managed lands in Watershed Administrative Units for which watershed analysis has been conducted, unless stated otherwise elsewhere in this HCP.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service are prioritizing watersheds for the conservation of salmon. DNR will consider the results of this prioritization when planning its participation in Watershed Analysis.

This section of Chapter IV will discuss the conservation objectives of the riparian conservation strategy for the five west-side planning units, the conservation components of the strategy, the rationale for the conservation components, and the effects of the strategy on salmonids.

Conservation Objectives

DNR identified two conservation objectives for the riparian conservation strategy for the five-west-side planning units:

(1) to maintain or restore salmonid freshwater habitat on DNR-managed lands, and

(2) to contribute to the conservation of other aquatic and riparian obligate species.

As described in Section D of Chapter III titled Salmonids and the Riparian Ecosystem, salmonid habitat includes the entire riparian ecosystem, and therefore, conservation objective (1) requires maintaining or restoring the riparian ecosystem processes that determine salmonid habitat quality. Also, as described in Section D of Chapter III, hydrological and geomorphological processes originating in upland areas may also affect salmonid habitat. Thus, conservation objective (1) further requires that the adverse effects of upland management activities be minimized. Contributions to the conservation of other aquatic and riparian obligate species, conservation objective (2), will occur indirectly through forest management that maintains or restores salmonid freshwater habitat.

Conservation Components

The riparian conservation strategy for the five west-side planning units defines the riparian management zone and describes future forest management with respect to unstable hillslopes, the road network, hydrologic maturity within the rain-on-snow zone, and wetlands.

RIPARIAN MANAGEMENT ZONE

The riparian management zone consists of an inner riparian buffer and an outer wind buffer where needed. (See Figure IV.7.) The principal function of the riparian buffer is protection of salmonid habitat; the principal function of the wind buffer is protection of the riparian buffer. Harvesting can occur within the buffers as long as management activities support these principal functions and are consistent with the conservation objectives.

Riparian Buffers

A riparian buffer shall be applied to both sides of Types 1, 2, and 3 waters (water types are defined in WAC 222-16-030). The width of the riparian buffer shall be approximately equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For the purposes of this HCP, the height shall be derived from standard site index tables (King 1966), using 100 years as the age at breast height of a mature conifer stand. When determining the width of the buffer, the site productivity used in the derivation will be that occurring in upland portions of the riparian ecosystem for that particular site. The site index table used will be that corresponding to the dominant conifer species occurring in the upland portion of riparian ecosystem. As discussed below, this prescription should result in average riparian buffer widths between 150 and 160 feet.

A riparian buffer 100 feet wide shall be applied to both sides of Type 4 waters. Type 4 waters classified after January 1, 1992, are assumed to be correctly classified. Type 4 waters classified prior to January 1, 1992, must either have their classification verified in the field or be assumed to be Type 3 waters. In general, it is currently standard practice for DNR staff to physically examine the classification of streams within a management unit when preparing the unit for a timber sale. If an area has already been classified post 1992 and prior to the effective date of this HCP, it is likely in a management activity area that is probably sold and/or harvested. Therefore, for all practical purposes, stream typing will be examined or verified in the field whether they were typed before or after 1992.

In the field, the width of the riparian buffer shall be measured as the horizontal distance from, and perpendicular to, the outer margin of the 100-year floodplain.

Figure IV.7: The relationship between the riparian ecosystem and DNR's riparian management zone

Thin lines denote the natural zonation of a forest landscape, i.e., the extent of the riparian ecosystem and the zones within the ecosystem. Thick lines denote areas of special forest management, i.e., the riparian management zone and the buffers within it. At most sites, the wind buffer is applied only as needed to the windward side of a stream. (Modified from Sedell et al. 1989)

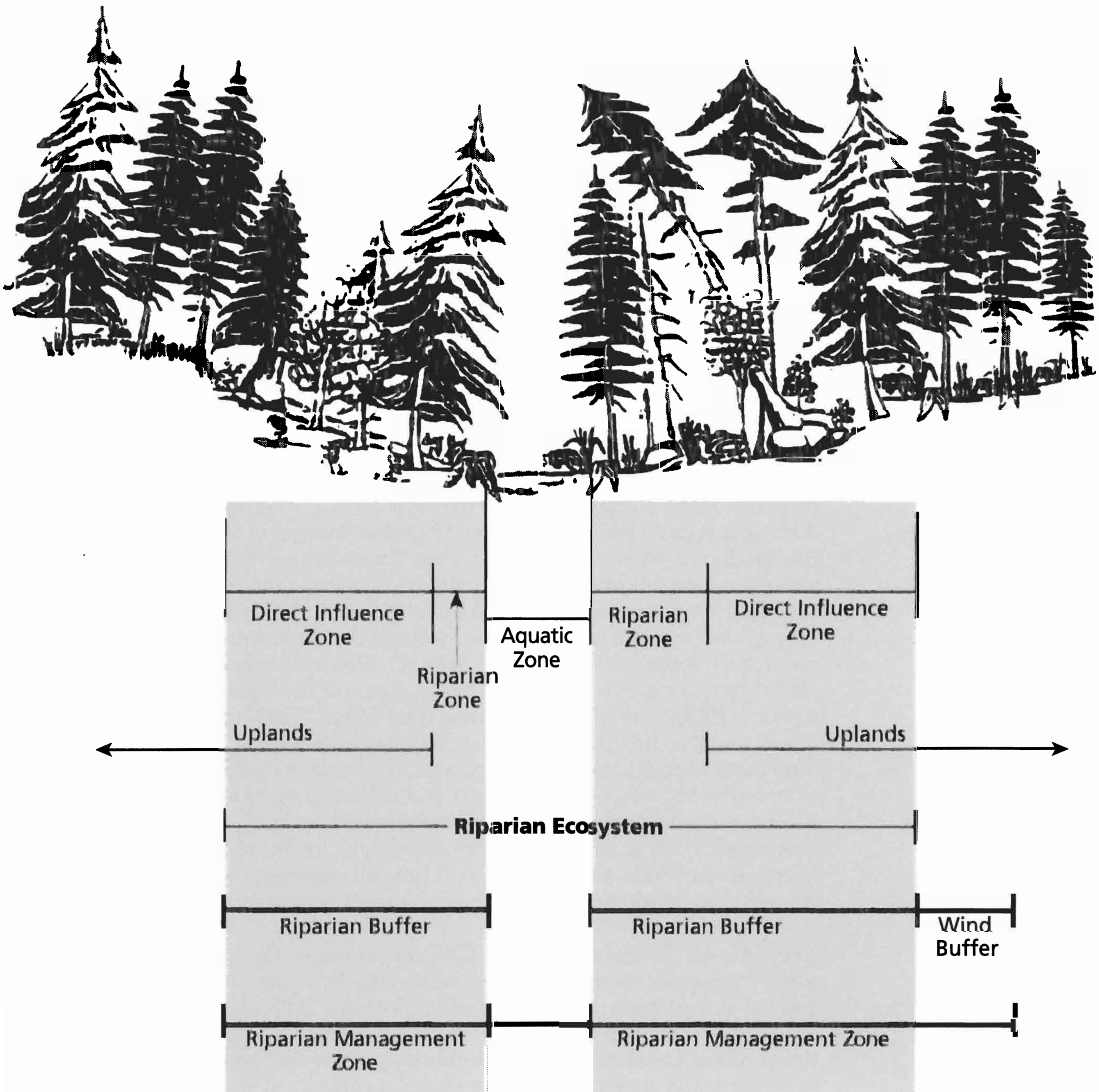


Table IV.5: Expected average widths of interior-core riparian buffers in the Olympic Experimental State Forest

Buffer widths will be determined on a site-specific basis using the proposed 12-step watershed assessment procedure (see text) and might vary locally with landform characteristics. Average widths are not expected to vary significantly, however, because these values are derived from a statistical analysis of buffer protection previously applied to about 55 percent of DNR-managed lands in the OESF. (See text for discussion.) Widths are expressed for each stream type as average horizontal distances measured outward from the 100-year flood-plain on either side of the stream.

Stream type	Width of riparian interior-core buffer (horizontal distances, rounded to the nearest 10 feet)
1	150
2	150
3	100
4	100
5	width necessary to protect identifiable channels and unstable ground (see text)

Average buffer widths are given in Table IV.5 as average horizontal distances measured outward from the outer margin of the 100-year floodplain on either side of the stream. The 100-year floodplain is the valley-bottom area adjoining the stream channel that is constructed by the stream under the present climatic regime and overflowed at times of very high discharge (i.e., flooding associated with storms of a 100-year recurrence interval, (Dunne and Leopold 1987)). One-hundred-year flood-plains commonly are delineated by the Federal Emergency Management Agency (FEMA) on Flood Insurance Rate Maps (FIRM) for each county of a state. The 100-year floodplain includes meandering, braided (i.e., multiple channel braids), and avulsion channels, as well as side channels that transport water from one part of a mainstream channel to another. Avulsion channels are portions of mainstream and side channels that have been abandoned temporarily by lateral displacement of the channel network elsewhere on the floodplain but are expected to be reoccupied when the network migrates back across the valley bottom.

The 100-year floodplain, which often encompasses the channel-migration zone, frequently occupies a several-hundred-foot wide section of the valley bottom on low-gradient, alluvial river systems. On higher-gradient streams in moderate to steep terrain, the 100-year floodplain typically coincides with the active channel margin or extends only a few feet beyond the active (e.g., the high-water mark). The active channel consists of the wetted area and bed or bank surfaces exposed during low flows, as well as portions of the valley bottom nearest the channel that are inundated during typical flood events (i.e. comparable to the two-year recurring flood). Active channel margins commonly are identified in the field by piles of accumulated flood debris, overbank sediment deposits, streamside vegetation altered or damaged by channel flows, bank scour, and the absence of aquatic biota (e.g., algae) normally found in slack-water channels. In the five west-side planning units and the OESF, DNR manages only a few hundred acres on 100-year floodplains of the major river systems. Most floodplain acreage is privately owned or federally managed. FEMA maps indicate that most

100-year floodplains are associated with Type 1 and 2 waters. Collectively, Type 1 and 2 waters represent less than 5 percent of the stream miles on DNR-managed lands. Hence, the impact to DNR management associated with using the 100-year floodplain as the inner margin of riparian management zones is relatively negligible. A method for determining the location of the active channel margin will be described in agency procedures to be developed for this HCP.

If Type 4 and 5 waters without fish become fishbearing upon removal of obstructions, they will be reviewed for proper typing. Type 4 or 5 waters documented to contain fish that are proposed or candidates for federal listing or federal species of concern will be treated as Type 3 waters, if appropriate.

All Type 5 waters that flow through an area with a high risk of mass wasting shall be protected as described in the subsection below titled Unstabled Hillslopes and Mass Wasting. During the first 10 years of this HCP, all other Type 5 waters shall be protected according to Policy No. 20 of the Forest Resource Plan (DNR 1992 p. 35). Under this policy, Type 5 waters are protected "when necessary for water quality, fisheries habitat, stream banks, wildlife, and other important elements of the aquatic system." In addition, during this interim 10-year period, a research program shall be initiated to study the effects of forest management along Type 5 waters located on stable slopes. At the end of the 10 year period, a long-term conservation strategy for forest management along Type 5 waters shall be developed and incorporated into this HCP as part of the adaptive management component.

Type 5 waters classified after January 1, 1992 are assumed to be correctly classified. Type 5 waters classified prior to January 1, 1992, will either have their classification verified in the field or be assumed to be Type 3 waters.

Wind Buffers

An outer wind buffer shall be applied on Types 1, 2, and 3 waters in areas that are prone to windthrow. Physical evidence of windthrow, windthrow models, and the potential for windthrow will guide the placement of wind buffers along riparian buffers. For Types 1 and 2 waters, where there is at least a moderate potential for windthrow, a 100-foot wind buffer shall be placed along the windward side(s). For Type 3 waters wider than 5 feet, where there is at least a moderate potential for windthrow, a 50-foot wind buffer shall be placed along the windward side(s). Where forest stands are subject to strong winds from multiple directions, it may be necessary to put wind buffers along the riparian buffers on both sides of the stream. If no evidence of windthrow exists or models predict a low risk of windthrow, then wind buffers will not be applied. The width and positioning of wind buffers may change as research concerning windthrow in managed forests, especially that conducted in the Olympic Experimental State Forest, finds solutions to the problem of minimizing windthrow. A method for determining on a site-specific basis the placement of the wind buffer will be described in agency procedures to be developed for this HCP.

ACTIVITIES IN THE RIPARIAN MANAGEMENT ZONE

Forest management activities that maintain or restore the quality of salmonid habitat shall be allowed within the riparian management zone. To ensure that this occurs, site-specific forest management activities along all Types 1, 2, 3, and 4 waters shall conform to the following:

(1) No timber harvest shall occur within the first 25 feet (horizontal distance) from the outer margin of the 100-year floodplain. Maintemance of stream bank integrity is the primary function of the

no-harvest area, and therefore, a wider no-harvest area will be established where necessary. DNR anticipates that only ecosystem restoration will occure in this area.

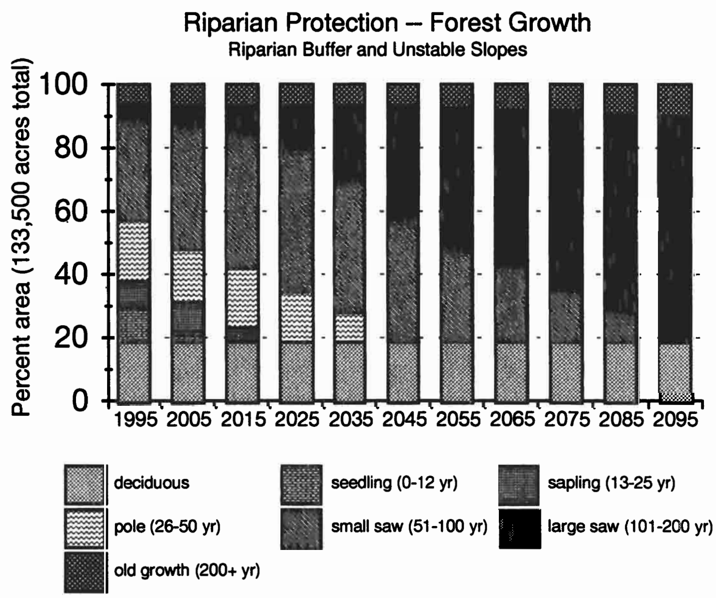
(2) The next 75 feet of the riparian buffer shall be a minimal-harvest area. Activities occurring between 25 and 100 feet (horizontal distance) from the 100-year floodplain must not appreciably reduce stream shading, the ability of the buffer to intercept sediment, or the capacity of the buffer to contribute detrital nutrients and large woody debris. Maintaining natural levels of stream temperature, sediment load, detrital nutrient load, and instream large woody debris is the primary function of the minimal-harvest area, and therefore, a wider minimal-harvest area will be established where necessary. DNR an-ticipates that only two types of silvicultural activities will occur in this area: ecosystem restoration and the selective removal of single trees.

(3) The remaining portion of the riparian buffer (more than 100 feet from the active channel margin) shall be a low-harvest area. DNR anticipates that selective removal of single trees, selective removal of groups of trees, thinning operations, and salvage operations will occur in this area. (See the discussion of salvage operations in the subsection titled Other Management Considerations, in Section A of this chapter on spotted owl mitigation.)

All forest management within riparian management zones will be site-specific, i.e., tailored to the physical and biological conditions at a particular site. All forest management in the riparian buffer shall maintain or restore the quality of salmonid habitat, but because of variation in site conditions, it is anticipated that the intensity of management will vary and that the forest stands which result from management will vary in both composition and structure.

To accommodate the greater flexibility afforded by managing riparian areas on a site-specific basis and the uncertainties surrounding the results of these activities conducted over time, an adaptive-management process will be used to specify management activities within riparian-management areas. Mechanisms used to achieve conservation objectives will vary as new information becomes available.

DNR believes that this strategy will lead, over time, to an age-class distribution within the riparian zones as depicted by the following graph:



Methods for making site-specific, forest-management decisions in the riparian mangement zones and wind buffers will be described in DNR's implementation procedures. These procedures will be developed by DNR and provided to the U.S. Fish and Wildlife Service and National Marine Fisheries Service for their review prior to being implemented. These procedures will, at a minimum:

(a) Describe in detail the conservation objectives.
These objectives will include desired outcomes for such items as maintaining bank stability, water temperature, shade, and natural sedimentation rates; retaining large trees and snags necessary to support viable populations of riparian wildlife and recruit future snags, coarse woody debris (downed logs on land), and large woody debris (in-stream logs); and maintaining the natural capacity of these areas to provide diversity including overstory composition, understory composition, detritus input, and natural pool frequencies.

(b) Define terminology, activities, and prescriptions.
For example, single-tree removal may be defined in terms of distance between removed trees and years between entries and may vary by site. It is expected that additional considerations such as lean of the tree, distance from stream bank, size, soundness, and abundance of other mature conifer would be factors considered during a site-specific analysis. The implementation procedures will provide guidance on how to incorporate those types of considerations. Similarly, the implementation procedures may describe how considerations of the rooting zone may extend the 25-foot no-harvest area on a site-specific basis using canopy diameters or other such indicators. Terms such as restoration, single-tree removal, minimal harvest, low harvest, etc. would be defined for each component of riparian management zones and wind buffers. Prescriptions for placement of yarding corridors and other such activities would also be included.

(c) Detail the monitoring methods to be used in the feedback process for adaptive management designed to ensure riparian-management zones and wind buffers are adequately providing the desired characteristics (e.g., large woody debris, stream stability, water temperature, snag densities, etc.); and

(d) Describe the training to be provided to agency staff.

These procedures will be developed by DNR and presented to the U.S. Fish and Wildlife Service and National Marine Fisheries Service within 12 months of signing the HCP documents. If the U.S. Fish and Wildlife Service and National Marine Fisheries Service do not agree with the procedures developed by DNR, a multi-agency science team will be convened to review the sufficiency of the procedures. Timber harvesting conducted within the riparian management zones and wind buffers prior to agreement on the proposed agency procedures will be subject to the following limitations:

- Within the 25-foot no-harvest area, only commonly accepted restoration activities may occur.

- Within the minimal-harvest area, low-harvest area, and wind buffer, partial harvests may occur that remove no more than 10 percent of the conifer volume and/or 20 percent of the hardwood volume per rotation.

However, if three months have passed since the U.S. Fish and Wildlife Service and National Marine Fisheries Service have received procedures developed by DNR and all three agencies have been unable to reach agreement on their sufficiency, DNR may increase timber harvest within the riparian management zones and wind buffers with the following limits:

(a) Within the 25-foot no-harvest area, only commonly accepted restoration activities may occur.

(b) Within the minimal-harvest area, single-tree or partial harvests may occur that remove up to 10 percent of the volume.

(c) Within the low-harvest area, partial harvests may occur that remove up to 25 percent of the volume.

(d) Within the wind buffer, partial harvests may occur that remove up to 50 percent of the volume.

UNSTABLE HILLSLOPES AND MASS WASTING

Unstable hillslopes will be identified through field reconnaissance or identified with slope geomorphology models (e.g., Shaw and Johnson 1995) and verified through field reconnaissance with qualified staff. If, in the future, timber harvest and related activities can be accomplished without increasing the frequency or severity of slope failure and without severely altering the natural input of large woody debris, sediment, and nutrients to the stream network, then such activity shall be allowed. A method for delineating on a site-specific basis the portions of hillslopes with a high risk of mass wasting will bedescribed in agency procedures to be developed for this HCP. Where slope stability models are less accurate (i.e., Southwest Washington), DNR will also rely on additional information, such as soil type databases.

Harvest operations will at times require that roads pass through areas with a high risk of mass wasting. Roads will be allowed to pass through such areas, but they must be engineered to minimize, to the fullest extent feasible, the risk of mass wasting and be routed through the use of a comprehensive landscape-based road network management process (below).

Road Network Management

On a Watershed Administrative Unit basis, DNR shall minimize adverse impacts to salmonid habitat caused by the road network. With this conservation objective in mind, a comprehensive landscaped-based road network management process shall be developed and instituted. Major components of this process shall include:

- the minimization of active road density;
- a site-specific assessment of alternatives to new road construction (e.g., yarding systems) and the use of such alternatives where practicable and consistent with conservation objectives;
- a base-line inventory of all roads and stream crossings;
- prioritization of roads for decommissioning, upgrading, and maintenance; and
- identification of fish blockages caused by stream crossings and a prioritization of their retrofitting or removal.

Prior to the completion of the landscaped-based road network management process, forest management activities will continue, provided they are consistent with conservation objectives.

BACKGROUND

Impacts from roads have been indicated to be important potential influences on many species of wildlife and fish and their habitats. For example, elk use closed roads as travel corridors (Ward 1976). Also, both elk and deer use of habitat increases with increasing distance from open roads (Lyon and Jensen 1980; Lyon 1979; Perry and Overly 1977).

Grizzly bears generally avoid roads and associated human disturbance, and the Grizzly Bear Recovery Plan recognizes road management as the single most important tool to manage and maintain suitable grizzly habitat (USDI 1993).

Wolf dens and rendezvous sites are often characterized by distance from human activity, and the Rocky Mountain Wolf Recovery Plan states, "Habitat for wolves is an adequate supply of vulnerable prey (ideally in an area with minimal opportunity for exploitation of wolves by humans)" (USDI 1987).

The Washington Department of Fish and Wildlife Draft Bull Trout/Dolly Varden Management and Recovery Plan (WDWF 1992) recommends closing roads permitting public access to spawning areas or access that facilitates poaching. Additional riparian impacts include increased sedimentation from road runoff and increased rates of slope failure caused by improperly constructed or poorly maintained roads (Murphy 1995).

The effects that roads have on the environment are influenced by what happens during the six distinct phases of road development: planning, design, construction, use, maintenance, and abandonment.

The planning phase determines road location across a landscape and has the single most significant impact on road density and road net configuration. In general, road spacing is determined by an economic balance between environmentally sound road transportation costs and environmentally sound yarding costs. At the site level, road spacing is controlled by topography that controls landing locations which are ultimately connected by a road network. Unstable slopes, wetlands, sensitive habitat, and other environmental issues are best addressed at this early stage as the location of a road will likely change very little once the control points are established.

The design phase ensures that a road will be built from one control point to another with sufficient width, usable grades, proper alignment, use of non-erosive surfacing material, adequate water drainage features, and stable cut-and-fill slopes.

Compliance with construction standards ensures that the road is built to the design specifications and ensures that the construction techniques minimize the amount of sediment moving from the road prism. If not carefully controlled, the construction phase can represent a significant percentage of the life cycle contribution of road sediment.

Forest roads are designed to handle traffic at some level of normal operations (road use). Roads are not typically designed to handle excessive loads or high volume traffic during very wet weather or during the thawing cycle associated with cold weather. Uncontrolled traffic can generate the largest percentage of the life cycle contribution of road sediment.

Maintenance operations attempt to keep the road at the designed level of performance. Maintenance primarily deals with keeping drainage structures functional and keeping the running surface usable. Maintenance cannot solve problems associated with a bad location, improper design, poor construction, or misuse.

Abandonment is an alternative to maintenance when the cost of maintaining a road segment is greater than the benefits of keeping the road open and environmentally sound.

DNR'S CURRENT ROAD MANAGEMENT STRATEGY

Current direction for DNR's road construction and maintenance program comes from Forest Practices regulations (WAC-222-24) and the 1992 Forest Resource Plan.

The objectives of DNR's current road management program are to:

(1) minimize further road related degradation of riparian, aquatic, and identified species habitat;

(2) plan, design, construct, use, and maintain a road system that serves DNR's management needs; and

(3) remove unnecessary road segments from the road net.

PLANNING

In general, DNR plans for high lead (800-foot optimum average yarding distance) yarding systems on land with slopes above 40 percent, and ground based systems (1000-foot average yarding distance) below 40 percent. This, together with topography, results in typical road densities between 0.5 to 6.0 miles per square mile.

DESIGN

DNR's design specifications meet or exceed Forest Practices regulations and hydraulic code requirements. Current road design standards call for 100-year flood design levels for water crossing structures, abutments of bridges to be outside the ordinary high water mark of streams, 18-inch minimum cross drain culverts, 12-foot running surfaces with 12-percent adverse and 18-percent favorable grades, and 60-foot minimum curve radius. Backslopes are designed according to soil type and meet or exceed the recommended angles required by Forest Practices regulations. Most Regions require that all roads on land with slopes greater than 40 percent be full bench construction with endhaul of excavated material when slopes exceed 55 percent or when within 100 feet of Type 1, 2 or 3 waters and wetlands. DNR also has minimum requirements for rock hardness and soluble degradation to reduce the amount of surface erosion generated from traffic.

CONSTRUCTION

DNR's road construction specifications meet or exceed the Forest Practices minimums. DNR requires compaction of fills in 2-foot layers, prohibits any woody debris from being incorporated into the fills, and often requires that the subgrade surface be compacted and graded prior to surface application. DNR prohibits construction during inclement weather and generally restricts construction to the dryer summer months.

ROAD USE

DNR currently allows all-season use of roads except for log truck traffic which may be restricted during periods of freeze-thaw cycles. DNR occasionally closes roads in agreement with the Washington Department of Fish and Wildlife for the purpose of game management. DNR also has occasional road closures related to fire control.

MAINTENANCE

DNR road maintenance specifications meet or exceed the Forest Practices minimums. Road maintenance activities focus on four main activities: timber sales, forest management, fire control access, and recreation. All roads are maintained to meet Forest Practices environmental and forest road safety standards. Each type of road has a different driveability standard that is linked to the type of vehicle used for each activity.

ABANDONMENT

When a road segment is determined to be too expensive to maintain, or is no longer needed, it is stabilized and abandoned. DNR is currently building more road per year than it is abandoning. While the number of miles of road per section is getting lower, the need to keep roads open longer coupled with the need to access additional acreage means the road network keeps growing. The need to keep roads open longer is driven by new environmentally sensitive approaches to harvesting, such as partial cutting and staggered settings. These silvicultural techniques dictate the need for multiple entries into a stand over the long term.

DNR'S HCP ROAD MANAGEMENT STRATEGY

In 1994, an analysis of the transportation information contained in the DNR GIS system showed that the average density of roads in the nine HCP planning units ranged from 1.69 to 3.29 miles per square mile although road density varies greatly within each planning unit.

The options available to DNR to reduce the mass wasting and surface erosion impacts to streams primarily focus on the amount and location of problem roads that are currently unnecessary and on how well necessary roads are managed. Road management can best be addressed with improved design, construction compliance, control of use, and maintenance management. Potential problems can best be addressed during a landscape-level planning phase.

DNR will initially focus on improvements in the more sensitive areas of a landscape with priority given to locations on steep slopes with unstable soil and high precipitation, and locations within 100 feet of Type 1, 2, and 3 waters and wetlands.

PLANNING

DNR will ensure that planning processes specifically include the consideration of longer yarding capacity systems whenever faced with placing roads in unstable areas. The alternatives generated during the planning process will be reviewed by an interdisciplinary team of foresters, scientists, and engineers who will evaluate the environmental, silvicultural, public use, and economic benefits and costs of these alternatives, and recommend harvest strategies for these sensitive areas. Alternate locations for new roads will be considered in more sensitive areas where other slope-parallel roads exist. The selection process will emphasize the overall goals of the HCP.

In considering road densities, it is assumed that the current emphasis on small staggered settings with greenup requirements, and partial-cut silvicultural systems designed to achieve environmental objectives will continue. These systems will, by their nature, result in more extensive road systems which will be active for longer periods of time. While expansion is inevitable as new areas are accessed, DNR's goal will be to reduce the additional amount of new roads needed through careful planning and control the overall size of the network by effective abandonment.

DESIGN

(1) In unstable areas, DNR will consider options such as:

- (a) road designs by professional engineers;
- (b) narrower running surfaces;
- (c) less steep cut and fill slopes;
- (d) more comprehensive slope revegetation/stabilization systems;
- (e) designed slope retaining structures;
- (f) larger and more frequent cross drains;
- (g) full bench on all roads located on 40 percent or greater side slopes;
- (h) endhaul of waste on all sideslopes greater than 55 percent;
- (i) subgrade and surfacing matrix enhancers (fabric, lime, concrete);
- (j) outsloping where appropriate;
- (k) permeable fills to stabilize sub-grades; and
- (l) other techniques for road-benching, including sliver-fills, back casting, and multi-benching.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

- (a) requiring higher quality rock surfacing specifications or the use of surfacing binders such as asphalt or lining sulfonate;
- (b) using more comprehensive cut and fill slope revegetation/ stabilization systems;
- (c) designing culverts and bridges for debris capacity as well as 100-year flood hydraulic criteria; and
- (d) placing sediment traps to avoid delivery of surface erosion into stream crossings, particularly at sites of through-cuts.

CONSTRUCTION

(1) In unstable areas, DNR will consider options such as:

- (a) slope stake design and compliance for road construction on 55 percent sideslopes;

(b) performing a thorough compaction of subgrade;

(c) prohibiting woody debris in all fills;

(d) using compact fills on slopes between 40 percent and 55 percent in 6-inch lifts with compacting machines designed for that purpose;

(e) controlling road construction shutdowns using moisture content indicators;

(f) employing controlled blasting, (e.g., pre-splitting) in order to avoid triggering landslides, especially during wet conditions; and

(g) using a backhoe rather than dozer to reduce ground disturbance.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) performing a thorough compaction of subgrade;

(b) using filter barriers downslope of construction;

(c) fully diverting flowing waters during culvert installation;

(d) installing silt filter devices at outlets of cross drains;

(e) delaying construction during inclement weather; and

(f) limiting the extent of exposed soils adjacent to a watercourse.

(3) Reconstructing necessary roads on unstable soils will be given high priority.

ROAD USE

(1) In unstable areas, DNR will consider options such as closing roads to log truck traffic during high rainfalls.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) closing roads to log truck traffic during high rainfalls;

(b) placing limits on volume hauled per day on marginal road segments;

(c) restricting hauling on some road systems to low pressure tire hauling vehicles (Central Tire Inflation);

(d) closing temporarily inactive road segments with gates; and

(e) installing silt filter devices at outlets of cross drains.

MAINTENANCE

(1) In unstable areas, DNR will consider options such as:

(a) employing road stabilization techniques that reduce the size of the road prism;

(b) stabilizing and armoring cut and fill slopes; and

(c) performing more frequent ditch and drainage structure maintenance.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) paving or lignin sulfonate surfacing stabilizers;

(b) performing more frequent ditch and surface maintenance; and

(c) resurfacing projects.

ABANDONMENT

DNR will become more aggressive in abandoning unneeded unstable roads and will increase the level of integrating abandonment of short use spurs in conjunction with timber sale activities.

HYDROLOGIC MATURITY IN THE RAIN-ON-SNOW ZONE

DNR shall minimize the adverse impacts to salmonid habitat caused by rain-on-snow floods. Two-thirds of the DNR-managed forest lands in drainage basins in the significant rain-on-snow zone shall be maintained in forest that is hydrologically mature with respect to rain-on-snow events. This prescription shall be applied to drainage basins that are approximately 1,000 acres or larger in size. A method for delineating the boundaries of drainage basins will be described in agency procedures to be developed for this HCP.

In some 1,000-acre or larger drainage basins there will be little risk of material damage to salmonid habitat during rain-on-snow floods, and in others, because of ownership patterns, DNR's management will not significantly decrease the risk of material damage. Therefore, DNR-managed forest lands need not conform to the basin hydrologic maturity prescription when:

- the basin has less than one-third of its area in the significant rain-on-snow zone; or

- the basin has at least two-thirds of its area in the significant rain-on-snow zone covered by hydrologically mature forests, and there is a reasonable assuraxnce that it will remain in that condition (e.g., forests in National Parks or National Forest Late successional Reserves); or

- the basin has less than one-half of its area in the significant rain-on-snow zone under DNR management, and there is no reasonable assurance that other landowners will contribute hydrologically mature forests (e.g., because land is in mines, farms, or housing developments). In such situations, an interdisciplinary team of scientists will be convened to develop a prescription for DNR-managed land within the drainage basin. Economic considerations will be included in the deliberations.

On the west side of the Cascades, conifer forests reach hydrologic maturity with respect to rain-on-snow events at approximately age 25. For the purposes of this HCP, hydrologically mature is defined as a well-stocked conifer stand at age 25 or older. DNR's geographical information system, which contains information on forest stand ages and tree species composition, will be used to determine the proportion of DNR-managed forest land in the significant rain-on-snow zone that is hydrologically mature.

The basin hydrologic maturity prescription is intended to be a straight forward way to provide a standard level of protection. In some basins, this will not be the most efficient means available to provide effective protection to salmonid habitat. Therefore, in places where DNR believes that effective protection can be provided in a more efficient way, DNR may use the Hydrologic Change Module of Watershed Analysis to develop drainage basin prescriptions. Once the analysis is complete and any necessary prescriptions are developed, the hydrologic maturity prescription specified in this HCP shall be waived.

In the future, DNR may conduct research to determine the relationship between soils within a drainage basin and adverse impacts to salmonid habitat during rain-on-snow floods. If it can be demonstrated, in a scientifically credible manner, that drainage basins consisting of certain soil types or soil parent materials have a low likelihood of adverse impacts to salmonid habitat during rain-on-snow floods, then such basins will not be required to conform to the basin hydrologic maturity prescription.

WETLANDS PROTECTION

Management activities in and around wetlands shall be consistent with the Forest Resource Plan Policy No. 21 (DNR 1992 p. 36), which states that DNR "will allow no overall net loss of naturally occurring wetland acreage and function." The primary conservation objective of the wetlands protection strategy is to maintain hydrologic function. This will be achieved through:

(1) continuously maintaining a plant canopy that provides a sufficient transpiration surface and established rooting;

(2) maintaining natural water flow (e.g., no channelization of surface or subsurface water flow); and

(3) ensuring stand regeneration.

The primary wetland functions that will be protected are the augmentation of stream flow during low-flow seasons and the attenuation of storm peak flows.

Wetlands to receive protection are those that fit the definition used by the state Forest Practices Rules (WAC 222-16-010). All wetlands 0.25 acre or larger shall be protected by a buffer. The minimum size of wetland to be protected was based on operational feasibility because wetlands smaller than this are difficult to locate. Wetlands that are larger than 1 acre shall have a buffer width approximately equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For the purposes of this HCP, the height shall be derived from standard site index tables (King 1966), using 100 years as the age at breast height of a mature conifer stand. Wetlands from 0.25 acre to 1 acre shall have a 100-foot-wide buffer. In the field, the width of the wetlands buffer shall be measured as the horizontal distance from, and perpendicular to, the edge of the wetland. Seeps and wetlands smaller than 0.25 acre will be afforded the same protection as Type 5 waters. That is, such features will be protected where part of an unstable hillslope. Research to study the effects on aquatic resources of forest management in and around seeps and small wetlands will be included in research programs for Type 5 waters.

Timber harvest within the forested portions of forested wetlands and wetland buffer areas shall be designed to maintain and perpetuate a stand that:

(1) is as wind-firm as possible;

(2) has large root systems to maintain the uptake and transpiration of ground water; and

(3) has a minimum basal area of 120 square feet per acre.

No road building shall occur in wetlands or wetland buffers without mitigation. Roads constructed within wetlands or wetland buffers shall require on-site and in-kind equal acreage mitigation in accordance with DNR's wetland policy. The effects of roads on natural surface and subsurface drainage shall be minimized.

Forestry operations in wetlands and wetland buffers shall be in accordance with DNR's policy of no overall net loss of wetland function. Forest management in forested wetlands and in buffers of nonforested wetlands will minimize entries into these areas and utilize practices that minimize disturbance, such as directional felling of timber away from wetlands and using equipment that cause minimal soil disturbance (e.g., tractors with low pressure tires). If ground disturbance caused by forest management activities alters the natural surface or subsurface drainage of a wetland, then restoration of the natural drainage shall be required. Soil compaction and rutting usually preclude the use of ground-based equipment in wetland areas. Salvage operations will be allowed within wetland buffers in areas that are not periodically flooded. (For discussion of salvage operations, see subsection titled Other Management Considerations, in Section A of this chapter on spotted owl mitigation.)

Rationale for the Conservation Components

RIPARIAN MANAGEMENT ZONE

The purpose of the riparian management zone is to maintain or restore the ecological functions in riparian and upland areas that directly influence salmonid freshwater habitat. Riparian management zones consist of a riparian buffer and, where appropriate, a wind buffer. Harvesting can occur, as long as management activities are consistent with the conservation objectives.

Riparian Buffers

The width of the riparian buffer is designed to maintain the functions of riparian ecosystem processes that influence the quality of salmonid freshwater habitat. Water temperature, stream bank integrity, sediment load, detrital nutrient load, and the delivery of large woody debris were the principal considerations used for designing the riparian buffer widths.

Large woody debris was considered especially important in the design of buffer widths because of the fundamental role it plays in aquatic ecosystems. Therefore, the primary design criterion of the riparian management zone was to provide the quantity and quality of instream large woody debris that approximates the quantity and quality provided by unmanaged riparian ecosystems. In a managed forest, the amount of large woody debris delivered to a stream from the direct influence zone is principally a function of buffer width and tree heights within the buffer

(Van Sickle and Gregory 1990; McDade et al. 1990). Therefore, in order to satisfy the primary design criterion, the width of the riparian buffer is based on tree height.

In western Washington, the direct influence zone of unmanaged riparian ecosystems typically consists of old-growth conifer forest. These old-growth conifer forests supply strong, large-diameter, long-lasting large woody debris to aquatic ecosystems. Simple geometry shows that instream large woody debris can originate from sites that are up to one tree height from the stream bank (Van Sickle and Gregory 1990). In fact, tree height is one of the main variables used to describe the spatial extent of the direct influence zone. On sites with moderate productivity (site productivity class III), Douglas fir often attain heights exceeding 200 feet. Thus, in a "typical" unmanaged riparian ecosystem, the direct influence zone may extend beyond 200 feet from the stream, and trees within this zone have a potential to become instream large woody debris.

However, the likelihood of falling into the stream is different for every tree and is related to the tree's distance from the stream — the closer a tree is to a stream, the greater the likelihood that it will end up as a log in that stream. The relationship between distance from stream and a tree's likelihood of becoming instream large woody debris is nonlinear. McDade et al. (1990) showed that in old-growth conifer forests, approximately 80 percent of instream large woody debris originates from distances within half an average tree height. The remaining 20 percent of instream large woody debris originates from distances beyond half an average tree height. In the "typical" unmanaged riparian ecosystem, that portion of the direct influence zone within 100 feet of the stream (approximately half an average tree) is critically important for supplying instream large woody debris. Beyond 100 feet, as the distance from the stream increases, the importance of the direct influence zone for contributing large woody debris decreases.

The primary design criterion of the riparian management zone is to provide the quantity and quality of instream large woody debris that approximates that provided by unmanaged riparian ecosystems. Managing the riparian management zone for a natural mix of hardwood and very large diameter conifer trees should provide the same quality of large woody debris as that found in unmanaged ecosystems. In a managed forest, the quantity of instream large woody is determined by the width of the riparian management zone and the amount of timber removed from the riparian management zone.

The width of an unmanaged riparian ecosystem is approximately equal to the site potential height of trees in an old-growth conifer stand. The width of the riparian buffer along Types 1, 2, and 3 waters is based on the site potential height of trees in a mature conifer stand. A mature forest stand is one in which the annual net rate of growth has peaked (Thomas et al. 1993). In general, conifer stands in the Pacific Northwest reach maturity between ages 80 and 100 years (FEMAT 1993; Spies and Franklin 1991). Conifer stands reach the old-growth stage at about 200 years (Spies and Franklin 1988, 1991). The site potential height of trees in a mature forest stand was selected as the basis for the riparian buffer width because Douglas fir and western hemlock, the principal conifer species in DNR-managed forests, obtain 70 to 80 percent of their old-growth height in the first 100 years of growth. Field measurements (McDade et al. 1990) indicate that buffer widths equal to approximately 60 percent of the average tree height will provide 90 percent of the natural level of instream large woody debris. Extrapolating from these results, a buffer width based on the 100-year site potential tree height, which is more than 60 percent of the height of old-growth trees, should provide more than 90 percent of the natural level of instream large woody debris.

Because most DNR-managed forests in riparian ecosystems are currently 60 years old or younger, the definition of tree height must take into account future growth. Site index curves are a practical means to predict future growth. Site index curves are nonlinear regressions of tree height versus breast height age for different site productivities (King 1966; Wiley 1978). The average 50-year site index calculated from DNR's geographic information system database is 106 for the five west-side planning units. Site index curves for Douglas fir (King 1966) and western hemlock predict that a site index of 106 yields a potential height of approximately 150 feet at age 100 years for both species. Based on DNR field data from 1991, the average 50-year site index of DNR-managed forests is 113 for the five west-side planning units. Site index curves for Douglas fir (King 1966) and western hemlock predict that a site index of 113 will yield potential heights of approximately 160 feet at age 100 years for both species.

On the least productive sites, i.e., site productivity class V, the potential heights at age 100 years for Douglas fir and western hemlock are predicted to be 86 feet and 102 feet, respectively. On the most productive sites, i.e., site productivity class I, Douglas fir is predicted to reach a total height at age 100 years of 215 feet, and western hemlock is predicted to reach 205 feet. Because the riparian conservation strategy calls for riparian buffer widths equal to the site potential height of conifers at age 100 or 100 feet, whichever is greater, the implementation of this strategy will result in buffer widths ranging from 100 feet to 215 feet, with an average width of approximately 150 feet to 160 feet.

In the five west-side planning units, Types 4 and 5 waters make up approximately 90 percent (by length) of the stream network on DNR-managed forest lands. Low-order streams (i.e., Types 4 and 5 waters) are the major link between hillslopes and higher order fish-bearing streams (FEMAT 1993; MacDonald and Ritland 1989). Low-order streams provide water, sediment, nutrients, and wood to downstream fish habitat (Swanston 1991; Potts and Anderson 1990; Richardson 1992; Conners and Naiman 1984; Bilby and Bisson 1992). Riparian management zones along all Type 4 and some Type 5 waters are intended to maintain the physical and biological processes that form this linkage.

Type 4 waters range from 2 to 10 feet in width, may not contain significant populations of salmonids, and may be perennial or intermittent (WAC 222-16-010). These small streams are significant because of their influence on downstream water quality (WAC 222-16-010). For the maintenance and restoration of salmonid habitat, current thinking is that Type 4 waters warrant less protection than Types 1, 2, and 3 waters. Under this HCP, a 100-foot-wide riparian buffer is applied to both sides of Type 4 waters. Buffer widths of 100 feet are thought to be effective in maintaining water temperature (Beschta et al. 1987), intercepting sediments (Lynch et al. 1985; Moring 1982), and providing detritus (Erman et al. 1977 as discussed in FEMAT 1993). One hundred feet is approximately 50 percent of the site potential height of old-growth (200-year-old) Douglas fir on a site with the average site productivity of DNR-managed forests. As discussed earlier, according to the results of McDade et al. (1990), the source of 80 percent of instream large woody debris lies within a distance equal to 50 percent of average tree height.

Wind Buffers

The stability and longevity of riparian buffers has been an issue of concern (Steinblums et al. 1984; FEMAT 1993). Windthrow may compromise the intended function of the riparian management zone. A single wind storm could raze entire sections of the riparian buffer, or successive high wind events may, over longer periods, slowly degrade the integrity of the riparian ecosystem. Windthrow is vital to riparian ecosystems — a significant proportion of all instream large woody debris (Murphy and Koski 1989, McDade et al. 1990) is blowdown — but the aerodynamics of the abrupt forest edges which commonly occur between riparian buffers and clearcuts cause more frequent catastrophic windthrow events or accelerated rates of blowdown. Gratowski (1956) measured windthrow along the edges of clearcuts in western Oregon. He reported that most windthrow occurred within 200 feet of the edge between forest and clearcut and was concentrated in first 50 feet. Excluding one extreme case of windthrow beyond 200 feet, Gratowski (1956) found that 77 percent of the blowdown occurred within 100 feet of the edge. Also, Gratowski (1956) observed that the amount of blowdown diminished by one-half for each successive 50 feet from the edge. Gratowski's studies took place only two years post-harvest, and therefore, he could not report on the continuing loss of standing live trees over longer periods of time.

The purpose of the wind buffer is to increase the stability and longevity of the riparian buffer, i.e., to maintain its ecological integrity. There are very few publications on the subject of stable wind buffer design (e.g., Steinblums et al. 1984). While the body of scientific knowledge regarding buffer wind stability is growing (Mobbs and Jones 1995; Sherwood 1993; Rot 1993; Harris 1989), it is currently inadequate for designing a long-term conservation strategy. Thomas et al. (1993) proposed a 100-foot-wide buffer to protect riparian buffers along fishbearing streams from wind and fire, and they did not explicitly propose a buffer to protect riparian buffers along non-fishbearing streams. Their proposal was intended to provide protection until a watershed analysis could be completed that would modify these interim buffer widths according to the characteristics of a given site.

The wind buffer specifications of this HCP should be considered interim. The width of the wind buffer may change as research concerning windthrow in managed forests, especially that conducted in the Olympic Experimental Forest State, finds means of minimizing windthrow. Monitoring the success of wind buffers in maintaining the ecological integrity of the riparian buffer will be an important element of this HCP.

ACTIVITIES IN THE RIPARIAN MANAGEMENT ZONE

In the riparian management zone, forest management activites will be site-specific, i.e., tailored to the physical and biological conditions at a particular site. As previously explained, the width of the riparian buffer is based on site-potential tree height, but because of variations in site-specific conditions, the intensity of forest management in the riparian buffer may vary. It is generally recognized that as the distance between management activities and the active channel margin decreases, the potential for adverse impacts to salmonid habitat increases. With this in mind, the no-harvest, minimal-harvest, and low-harvest areas of the riparian buffer were developed to guide management activities.

The no-harvest area is intended to maintain stream bank integrity by (1) eliminating disturbances to fragile stream banks and (2) protecting the vital contribution of tree roots to stream bank integrity. Root strength of conifers is thought to decline greatly at distances greater than a tree crown radius (FEMAT 1993). Crown radii are mainly a function of stand density and vary widely. Using a simple stand model that assumes maximum stand density, one can show that crown radii of Douglas fir rarely exceed 25 feet. Therefore, within 25 feet of the stream bank, all trees should be retained to achieve the maximum level of soil stabilization provide by root systems.

Buffer widths of 100 feet are thought to be effective in maintaining water temperature (Beschta et al. 1987), intercepting sediment (Lynch et al. 1985; Moring 1982), and providing detritus (Erman et al. 1977 as discussed in FEMAT 1993). The specifications for the minimal-harvest area, which extends to 100 feet from the active channel margin, were based on these research results and recommendations and are intended to maintain natural instream levels of these three key elements of salmonid habitat. The same results and recommendations are the basis for the 100-foot minimum width of the riparian buffer along Type 4 waters.

One hundred feet is approximately 50 percent of the site potential height of old-growth (200-year-old) Douglas fir on a site with the average site productivity of DNR-managed forests. According to the results of McDade et al. (1990), the source of approximately 80 percent of instream large woody debris lies within a distance equal to 50 percent of average tree height. Based on these research results, forest management in the minimal-harvest area should retain most, and at some sites all, of the standing trees (dead or live) to serve as a source of large woody debris.

DNR anticipates that only two types of activities will occur in the minimal-harvest area: ecosystem restoration and selective removal of single trees. The principal conservation objectives of riparian ecosystem restoration will be to achieve a more natural mix of hardwood and conifer species and to enhance the development of old conifer forests. One means of addressing this objective may be to accelerate forest succession through the selective removal of hardwoods (e.g., red alder) and the replanting of conifer species. Another means may be to accelerate tree growth through precommercial or commercial thinning.

The low-harvest area of the riparian buffer (i.e., beyond 100 feet from the active channel margin) is important for contributing large woody debris, intercepting sediment on steep slopes (Broderson 1973), and in some places, maintaining natural levels of stream shading (Steinblums et al. 1984). A process will be developed for assessing site-specific conditions and determining the silvicultural activities that may occur that meet the conservation objective "to maintain or restore the quality of salmonid habitat." For the leeward side of streams where there is no wind buffer, the low-harvest area must serve the additional function of maintaining forest health. Clearcuts change the microclimate of adjacent forest stands (Chen et al. 1995). These changes may exert a physiological stress on trees that may result in their increased susceptibility to pests and diseases. To maintain the ecological integrity of the riparian ecosystem, the low-harvest area will be managed to mitigate microclimatic changes in the minimal- and no-harvest areas.

Yarding through the riparian management zone creates a break in the vegetation and disturbs stream banks. This could lead to short-term increases in water temperature and sediment. However, road construction results in long-term increases in water temperature, sediment, and alteration of basin hydrology. Therefore, in general, yarding logs through riparian areas is less damaging to aquatic resources than new road construction.

UNSTABLE HILLSLOPES AND ROADS

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 Swanston 1980; Chesney 1982; Everest et al. 1987; Sidle 1985). In the Pacific Northwest, roads appear to cause more landslides than does 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, landsliding occurs where soil pore water pressure increases to a degree that the friction between soil particles is inadequate to bind them together and the soil consequently slides downslope under the force of gravity. Timber harvest affects the local soil pore water pressure in at least two ways until the new trees reach hydrologic maturity. First, transpiration decreases following tree removal. Decreased transpiration increases soil moisture, thus increasing the risk of slope failure. Second, because 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 of harvested trees decay, this strength is lost, and the likelihood of landsliding increases until new root systems are established.

Roads in upland areas have significant detrimental impacts on salmonid habitat. 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. (1981) 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 to 300 times as compared to undisturbed forests (Furniss et al. 1991).

HYDROLOGIC MATURITY IN THE RAIN-ON-SNOW ZONE

The strategy for managing the amount of hydrologically mature forest is intended to prevent damage to salmonid habitat during peak flows associated with rain-on-snow events. (See Section C of Chapter III titled Salmonids and the Riparian Ecosystem.) The strategy follows the principles used to develop the 1991 emergency state Forest Practices rule on rain on snow.

A subbasin in western Washington that 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 subbasin 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 more than 1 inch of water to the amount accumulated in a 10-year 24-hour storm, i.e., a storm of moderate intensity, present an unacceptable 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 1994) and their current application by hydrologic analysts. In watershed analysis, increases of peak flow greater than

10 percent may adversely affects public resources. Also, 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 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, and Parson 1976 as discussed in 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 1,220 acres.

In addition, a poll of watershed analysis reports shows that most hydrologic analysis units (defined through the watershed analysis process to calculate peak flows) are greater than 900 acres. In a few instances, the hydrologic analysis units are as small as 350 acres, but these are fragment areas between basins of significant creeks. Most hydrologic analysts involved in watershed analysis delineate hydrologic analysis units that are 1,000 acres or more.

In some 1,000-acre or larger drainage basins there will be little risk of material damage to salmonid habitat during rain-on-snow floods. For example, as discussed previously, in basins with less than one-third of the area in the significant rain-on-snow zone, the estimated additional yield caused by rain-on-snow during a 10-year 24-hour storm is less than 1 inch. For similar reasons, in basins with at least two-thirds of the area in the significant rain-on-snow zone covered by hydrologically mature forests that are reasonably assured of remaining 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, because of ownership patterns, DNR's 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 landowners did not manage for hydrologically mature forest and DNR maintained two-thirds of its forest lands in a hydrologically mature condition, then 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 the hydrologically immature area would be 2 inches. DNR management in this case would not significantly decrease the risk of material damage because a 2 inch additional yield would likely cause material damage to salmonid habitat.

WETLANDS PROTECTION

In many watersheds, wetlands have a profound influence on hydrology and water quality. The conservation strategy for wetlands is intended to maintain the wetland functions of moderating stream flows and enhancing water quality.

Through the process of evapotranspiration, plants move water from the ground to the atmosphere. Evapotranspiration affects water table and soil moisture levels, and consequently timber harvest in and around a wetland can affect the hydrologic regime of the wetland. The principal organs of evapotranspiration are leaves, and a minimum leaf area per acre is necessary to maintain the hydrologic regime of a forested wetland. Leaf area is measured by leaf area index, and a leaf area index of 30 should maintain at least 95 percent of the potential evapotranspiration in a forest stand (U.S. Environmental Protection Agency 1980). Through an allometric relationship, stand basal area may be used as a surrogate for leaf area index (USEPA 1980). A basal area of 120 square feet per acre corresponds to a leaf area index of 30 (USEPA 1980).

Because of the wet soils and shallow tree rooting typical of forested wetlands, trees in such areas are more susceptible to windthrow. The harvest of trees from areas in and around wetlands often results in even wetter soils and a consequent increase in the potential for windthrow. Furthermore, after harvest, the lower stem density of the residual stand provides less shelter from strong winds. The cumulative effects of harvest on the hydrologic regime of the wetland continue through time as trees are lost through windthrow. Therefore, it is important that trees left after harvest be among the most wind-firm in the forest stand.

Effects of the Riparian Conservation Strategy on Salmonid Habitat

Many factors, both human-caused (fisheries management, hydropower dams, agriculture, and municipal development) and natural (El Niño), affect salmonid populations, and these are beyond the control of DNR. The role that DNR, or any forest manager, has in the fate of a particular salmonid population is difficult to gauge, but the effects that a forest manager has on the quality of salmonid freshwater habitat can be shown. Therefore, salmonid freshwater habitat will be used as a proxy to evaluate the effects of the riparian conservation strategy on salmonids.

The forest management described in the riparian conservation strategy will result in improved salmonid habitat on DNR-managed lands. The improvement will occur as:

(1) deciduous and young conifer forests within riparian ecosystems develop into older conifer forests;

(2) young forests on unstable hillslopes develop greater root strength and reach full hydrologic maturity; and

(3) the adverse impacts of roads are reduced through comprehensive landscape-based road network management.

Prescriptions for the significant rain-on-snow zone and wetlands should minimize the potential adverse impacts of forest management on winter peak-flows and summer low-flows.

At present, 49 percent of forests in riparian buffers of the riparian management zone are even-aged conifer forest younger than 60 years old, 25 percent are deciduous forest, and 26 percent are conifer forest older than 60 years. Much of the riparian deciduous forest on DNR-managed lands developed naturally following timber harvesting. Therefore, as a result of forest management, more than half of the riparian ecosystems on DNR-managed lands do not contain the large conifer trees essential for providing instream large woody debris, which is one of the most important elements of salmonid habitat. Also, in some harvest units, the current riparian management zones along Types 3 and 4 waters may not be adequate to maintain stream bank integrity and natural levels of stream shading, sediment load, and detrital nutrient load.

Under this HCP, the riparian buffer will be managed to maintain or restore salmonid habitat. Given this conservation objective, the no-harvest and minimal-harvest areas of the buffer are anticipated to develop into forest with old-growth characteristics, i.e., large old trees, multilayered canopy, and numerous snags and logs. The low-harvest area will be managed according to the same conservation objective, but its distance from water may permit more harvest, and therefore it is anticipated that in most instances the low-harvest area will eventually have a range of uneven-aged mature forest characteristics. The low-harvest area is intended to provide some large woody debris to the aquatic and riparian zones, and therefore, large trees will be retained for this purpose. The width of the riparian buffer and the management within it should be adequate to maintain stream bank integrity and natural levels of stream shading, sediment load, and detrital nutrient load.

At present, DNR has no standard practices for the protection of riparian management zones from windthrow. Under the HCP, the ecological integrity of the riparian buffer, and the salmonid habitat contained therein, will be protected by wind buffers. Management within the wind buffers will be largely experimental, and therefore, the forest conditions within the wind buffer cannot be accurately predicted.

Unstable hillslopes are estimated to occupy an additional 5 to 10 percent of DNR-managed lands outside the riparian management zone. At present, 30 percent of these areas are in even-aged conifer forests younger than 40 years old, 13 percent are in deciduous forest, and 47 percent are in older conifer forest. Under this HCP, harvest in these areas and other areas identified as having a high risk of mass wasting will be deferred until it can be demonstrated that such activity can be accomplished without increasing the frequency or severity of slope failure. As the forests in these areas develop, the frequency of mass-wasting events on DNR-managed lands should decrease.

Roads have been proven to cause significant adverse impacts to salmonid habitat. Under this HCP, the road network will improve, but improvements are anticipated to occur gradually because of the tremendous costs. DNR has already begun a shift toward more ecologically sensitive road management, and the incorporation of road network management into the riparian conservation strategy demonstrates DNR's commitment to a continual improvement of the road network.

Road network management will be at a landscape level. Road inventories, routing, cumulative effects analysis, and the prioritization of construction, maintenance, and decommissioning will consider an entire landscape. Road network management will consider multiple-use objectives and constraints, identify road uses and users, establish a long-term planning horizon, and maintain a timeline for each road, from construction to periodic maintenance and eventual decommissioning.

The riparian conservation strategy should result in high quality salmonid habitat in the fishbearing waters on DNR-managed lands. Nevertheless, during the term of this HCP, adverse impacts to salmonid habitat will continue to occur because past forest practices have left a legacy of degraded riparian ecosystems, deforested unstable hillslopes, and a poorly planned and maintained road network. The frequency and severity of these adverse impacts will decrease as forests develop and the road network improves. The riparian conservation strategy, which includes active restoration of some riparian ecosystems and improvements to the road network, will serve to minimize and mitigate the adverse impacts of past management.

Forest management entails a myriad of activities, and many of these can have an adverse impact on salmonid habitat. Timber harvesting, road building, road use, site preparation, herbicide application, mineral extraction, power line rights-of-way, fire control, and other lawful forest management activities will continue to occur and may have an adverse impact on salmonid habitat. In addition, during the first 10 years of this HCP, Type 5 waters not associated with unstable slopes will be protected only "when necessary for water quality, fisheries habitat, stream banks, wildlife, and other important elements of the aquatic system" (DNR 1992 p. 35). However, the riparian management zone along Types 1, 2, 3, and 4 waters will minimize the adverse impacts of timber harvesting, site preparation, and herbicide application on salmonid habitat. Logs may still be yarded across streams and roads built over streams, but the impacts from these activities will be infrequent and localized. Changes in drainage basin forest cover will continue to affect the water available for runoff and water yields, but the components of the riparian strategy addressing management in the significant rain-on-snow zone and wetlands should minimize and mitigate these adverse impacts.

Some components of the riparian conservation strategy require on-site management decisions, and adverse impacts to salmonid habitat may occur inadvertently. For example, timber harvesting in the riparian buffer must "maintain or restore salmonid habitat", but, at present, the amount of timber harvesting in riparian ecosystems compatible with high quality salmonid habitat is unknown. In the early stages of this HCP, the amount of timber harvested from the riparian buffer or the methods used for its extraction may harm salmonid habitat. The same can be said for the management of the wind buffer or harvest on unstable slopes. Through research, monitoring, and systematic application of the knowledge gained, adverse impacts should decrease in frequency and severity.