WATERSHED RESTORATION PLAN

for National Forest System Lands within the

CALAWAH RIVER WATERSHED

(Sitkum, North and South Fork Calawah and Elk Creek)

March, 2011

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The Forest Service's Pacific Northwest Region Aquatic Restoration Strategy is a region-wide effort to protect and restore aquatic habitat across Washington and Oregon. The strategy relies on a collaborative approach to restoration and on focusing available resources in selected high priority watersheds to accomplish needed restoration activities on national forest system lands as well as other ownerships. In 2010 the Olympic National Forest selected the Calawah River watershed (5th field) as its "Focus Watershed" for the Washington Coast basin. Over the next several years the Forest Service will emphasize restoration within the Calawah River watershed and will work with partners to complete the high priority projects needed to protect and restore salmon and steelhead habitat in the basin.

Salmon and steelhead habitat protection and restoration efforts are needed throughout the Olympic Peninsula. It is not feasible or reasonable to concentrate all potential recovery projects within a single watershed and ignore the needs of other basins. We recognize that the Washington Coast Sustainable Salmon Partnership, the North Pacific Coast Lead Entity, and other organizations interested in salmon

recovery will continue to implement priority projects on various streams throughout the peninsula as opportunities present themselves and resources become available.

The first step in the "Focus Watershed" process was to form a collaborative group of interested individuals to develop and implement a multi-year action plan aimed at promoting recovery of key aquatic processes and functions in the Calawah River watershed. The objective was to identify all high priority actions needed to protect and restore salmon and trout habitat within the watershed. While the focus of the group was on National Forest lands, the group also identified high priority aquatic restoration needs on other ownerships throughout the watershed.

Partners in the collaborative team include some of the current members of the North Pacific Coast Lead Entity (NPCLE) such as the Quileute tribe, the City of Forks, the Pacific Coast Salmon Coalition, Rayonier Timberlands, the Washington Department of Natural Resources, the Wild Salmon Center, and Clallam County. Additional participants in the collaborative team include the Olympic Forest Coalition, outdoor recreationists, interested private citizens and area residents.

This action plan, developed within the collaborative group framework, identifies the high priority work which is needed to protect and restore watershed health, water quality, and fish habitat on National Forest System (NFS) lands within the Calawah watershed. It targets the correction and improvement of conditions that pose a high risk to aquatic resources, provides estimated costs for the work, and outlines a general schedule for completion. The plan also demonstrates the alignment to larger scale efforts including: Forest Service Pacific Northwest Region Aquatic Restoration Strategy; Olympic National Forest Strategic Plan; Olympic National Forest Site-Specific Invasive Plant Treatment Project; Washington Coast Sustainable Salmon Partnership regional salmon restoration and recovery plan; North Pacific Coast (WRIA 20) Salmon Restoration Strategy; Quillayute Watershed Prioritized Salmon Restoration Projects; and Clean Water Act water quality improvement plans.

WATERSHED BACKGROUND

The Calawah River watershed originates in the Olympic Mountains, with elevations ranging from 3000 feet at the ridge tops to below 500 feet in the lowlands. The watershed encompasses over 86,000 acres. The three main rivers within the watershed are the North Fork Calawah, the South Fork Calawah and the Sitkum River. Elk Creek is a significant salmon producing stream in the lower Calawah watershed. The Calawah River derives its English name from its Quileute name, meaning 'in between, in the middle,' since it was the river (and area) that lay between 2 focal watersheds of Quileute country, the Sol Duc and Bogachiel Rivers. The major landowners in the Calawah River watershed are the Olympic National Forest, Olympic National Park, Washington Department of Natural Resources, Rayioner Timberlands, the City of Forks, and individual small private landowners. Homesteading of the Forks Prairie in the extreme western portion of the South Fork Calawah mainstem occurred in the 1850's.

Some timber salvage operations may have occurred after the devastating windstorm of 1921. Commercial logging began along the Sitkum River mainstem in the 1940's. Hyas Creek and Rainbow Creek had been minimally entered at the time of the Great Forks Fire in 1951. The Great Forks fire, which originated in the Sol Duc watershed and jumped over to the North Fork Calawah watershed, burned 33,000 acres in 8 hours. The fire burned through Hyas Creek, the northwest half of the Rainbow

Creek drainage and the north edges of the Lower Sitkum drainage. Subsequent to the fire both drainages underwent extensive roading and salvage logging. Since the early 1950's extensive road systems have been built to facilitate timber harvest. Chronological aerial photo analysis of the Sitkum, and the North and South Fork Calawah subwatersheds indicate an increased frequency in mass wasting following timber harvest and road building. Mass wasting has resulted in large amounts of fine and coarse sediment being delivered into the tributaries and mainstems. Clearcut logging continued until the 1990's when the Northwest Forest Plan was adopted.

There are currently 163.6 miles of National Forest system roads within the Calawah watershed (Appendix B). The Olympic National Forest Access and Travel Management Plan (ATM) which was completed in 2003, identified 145.3 miles of road as having a moderate , high, or very high risk to aquatic resources because of the location of the roads in unstable terrain, the number of stream crossings, or the proximity of the roads to stream channels (Appendix A). The ATM plan evaluated future projections for Forest Service road maintenance funding and the needs for vehicle access against the potential risks to aquatic resources and recommended decommissioning a total of 57.1 miles of roads within the watershed. The road mileage totals above do not include unclassified, abandoned roads that are not on the Forest road network. During the recent Sitkum and South Fork Calawah timber sale planning process an additional 29 miles of abandoned road were identified in those drainages.

One of nature's geological oddities is worth mentioning. In the North Fork Calawah stretches of the mainstem channel that drain between 22 sq. miles and 32 sq. miles go dry during the summer months and occasionally during winter dry periods. This unusual hydrologic regime is directly related to retreating glaciers some 12,000 years ago. Meltwater from the glaciers used the North Fork Calawah valley as an outwash channel and deposited the sands and gravels found there today.

The Calawah River watershed supports significant runs of native salmon and steelhead including winter and summer run steelhead, fall coho, summer and fall Chinook, river-run sockeye, resident and sea-run cutthroat trout, and chum salmon. The watershed also provides habitat for non-salmonid species such as mountain whitefish, pacific lamprey, and sculpins.

The South Fork Calawah and Sitkum River watersheds are utilized by substantial populations of Chinook salmon, coho salmon, and steelhead trout, along with small populations of river-run sockeye salmon and chum salmon. Pacific lamprey and mountain whitefish are present in the lower mainstems of both drainages, although information on habitat utilization is very limited. Resident and sea-run cutthroat trout and sculpins are found throughout most of the watershed.

Natural geologic processes and man-made disturbances have helped shape fish distribution and habitat productivity. Drainages on the northern slopes of the Sitkum and South Fork Calawah watersheds, such as Hyas Creek, Rainbow Creek and the North Fork Sitkum River have bedrock falls which are migration barriers for anadromous fish. Of these three drainages only Hyas Creek has limited anadromous fish usage up to a barrier falls at RM 1.9. Resident cutthroat trout and sculpins are found in the North Fork Sitkum River, while no fish of any species have been found in Rainbow Creek. Anadromous fish usage in Lost Creek, which drains off the watershed's southern slopes, is limited only by stream gradient. In the upper Sitkum River mainstem a large debris jam may be the limiting factor for anadromous fish migration.

The lower, middle, and upper South Fork Calawah subwatersheds are within the Olympic National Park and are subject only to natural disturbances. These subwatersheds function as refugia habitat. Lost Creek appears to be a relatively stable watershed with intact riparian vegetation, due to limited timber harvesting and road building. Hyas Creek has very limited amounts of LWD in the stream channel and young riparian vegetation, likely the result of the Great Forks Fire of 1951 and subsequent salvage operations. Significant numbers of winter steelhead and fall Chinook spawn in the wide tailouts and riffles of the mainstem Sitkum and South Fork Calawah Rivers. Fall coho utilize Lost Creek and Hyas Creek.

The South Fork Calawah River provides a high quality sport fishery between its confluence with the Sitkum and North Fork Calawah Rivers. Tribal in-river gillnet fisheries are active in the Quillayute and lower Bogachiel Rivers, well outside the Calawah watershed boundaries. A Washington State Department of Fish and Wildlife steelhead hatchery is located 8 miles downstream of the South Fork Calawah River, on the mainstem Calawah River. All fish production in the Sitkum and South Fork Calawah Rivers is currently from natural production, though in past decades juvenile salmon may have been planted in some tributaries

According to the *2002 Salmonid Stock Inventory* (SaSi), Calawah River fall and summer Chinook, fall coho and winter steelhead are rated as healthy. Summer run steelhead is listed as unknown due to lack of information on which to make a rating.

There are no known spawning populations of bull trout/native char in the Calawah watershed. Within the Quillayute basin, the only identified population of bull trout/Dolly Varden is found in the Sol Duc River, above the Sol Duc Falls at RM 65.5. This population above the falls is a resident population (SSI, 1998). Until 2009, there had been no sport angler reports of native char caught in the lower Sol Duc River or Quillayute system. In 2009 a sport angler fishing the lower Calawah River mainstem at @ RM 1-2, caught a native char. There are no known populations of bull trout in the Quillayute system, but foraging individuals may "dip in" from systems along the coast with known populations.

WATERSHED RESTORATION WORK COMPLETED THROUGH 2009

A variety of restoration projects have been completed over the last several decades in the North Fork Calawah, South Fork Calawah and Sitkum River drainages. Projects have included road decommissioning, road stabilization, correcting culvert fish passage barriers, riparian vegetation improvement, invasive plant inventory, treatment and monitoring, and large woody debris placement. A total of 29.8 miles of road have been decommissioned, 2 anadromous barrier culverts have been corrected, and 2.5 miles of stream channel have been improved by placement of LWD. The following is a break down by drainage of previous restoration accomplishments:

North Fork Calawah

- Road decommissioning – 12.4 miles of Forest Service roads have been decommissioned including 4.7 miles of road along Cool Creek, a major salmon steelhead producing stream;
- Fish passage – Two anadromous culvert migration barriers have been corrected. One barrier culvert was replaced with a bridge. A second barrier culvert on the FS 2923-060 road was permanently removed, tributaries 0183A and 0184;

- Riparian restoration – conifer seedlings have been planted (Figure 1)and existing suppressed conifers have been released along several miles of the mainstem and tributaries 0183A and 0184;
- LWD placement – A series of log jams and individual logs (Figure2) have been placed throughout one mile of the mainstem and tributaries 0183A and 0184, in partnership with Pacific Coast Salmon Coalition.

Figure 1, Large woody debris placement in tributary 0184. **Figure 2 Riparian conifer planting.**

South Fork Calawah:

- Road decommissioning – 7.4 miles of Forest Service roads have been decommissioned, including 4.8 miles in Lost Creek, one of the least disturbed streams in the Olympic NF;
- LWD placement – A series of log jams and log complexes (Figure 3) have been placed throughout 1.5 miles of Hyas Creek, a significant salmon and steelhead producing stream;
- Off-channel habitat – An overwintering pond was constructed along the mainstem South Fork Calawah (Figure 4). It is utilized by juvenile coho, steelhead and cutthroat trout.
- Invasive plant treatments using manual and herbicide methods

Figure 3. Woody debris Hyas Creek.

Figure 4. Overwintering pond, mainstem South Fork

Sitkum River

- 8.7 miles of Forest Service roads have been decommissioned.

Elk Creek

- 1.3 miles miles of Forest Service roads have been decommissioned.

WATERSHED RESTORATION WORK REMAINING

Many of the remaining high priority watershed restoration projects that need to be completed to protect and restore aquatic habitat in the Calawah River watershed have already been identified in existing documents including the Quillayute Watershed Prioritized Salmon Restoration Projects (Hunter, 2006), the North Pacific Coast (WRIA 20) Salmon Restoration Strategy (North Pacific Coast Lead Entity, 2010), the North Fork Calawah Watershed Analysis (USFS et. al., 1996), the Sitkum/ South Fork Calawah Watershed Analyses (USFS and ONP, 1998), and the recent Sitkum and South Fork Calawah Restoration Summary (USFS 2010). These documents and subsequent field recon and data gathering by aquatic and road maintenance personnel form the basis of the restoration action plan.

A small working group comprised of representatives from the Forest Service, the Quileute tribe, the Pacific Coast Salmon Coalition and local citizens met to validate high priority restoration projects previously identified in existing documents and to identify additional high priority restoration projects on both National Forest lands and non-Forest Service lands. The following goals were used to identify high priority restoration projects within the Calawah watershed:

- Reconnect disconnected habitats;
- Increase Large Woody Debris in areas of potentially high productivity for salmon and steelhead;
- Reduce or eliminate the potential for road related landslides/sedimentation that directly impact salmon and steelhead;
- Develop off-channel overwintering habitat;

- Improve future sources of LWD recruitment in riparian areas dominated by alder or dense second-growth plantations.
- Restore native plants and treat Japanese knotweed and other invasive plants in riparian areas.

Table 1 lists the high and moderate priority projects needed to protect and restore salmon and steelhead habitat on Forest Service lands within the Calawah watershed. On National Forest System lands the group identified:

- 24.4 miles of road decommissioning on road segments that present high risk to aquatic resources.
- 67 miles of drainage and stabilization work on roads that will remain open and drivable on the National Forest road network.
- 10 miles of Level 1 storage to close the road to vehicles, stabilize the roadbed, and insure adequate drainage while maintaining the opportunity to use the road again in the future. Level 1 storage is an intermediate step between drainage and stabilization and full decommissioning which potentially involves more aggressive drainage treatment.

Total estimated cost for needed restoration work on national forest system lands is approximately $ 6,957,740. Costs include project planning and design, contract preparation, and contract administration as well as funds needed to award contracts.

Inventories of unclassified, abandoned roads are not complete and additional high priority restoration needs may be identified on some of these road segments in the future. An inventory of existing ORV trails within the watershed is also underway and may identify additional sedimentation or fish passage issues that need to be addressed to protect and restore aquatic habitat. Periodic inventories for invasive plants are needed, as well as restoration strategies for native plant species.

If additional restoration project needs are identified, they will be added to Table 1 and included in the restoration action plan.

This restoration plan just identifies the work needs to protect and restore salmon and steelhead habitat on national forest system lands within the Calawah watershed. It is not a decision document. As funding becomes available, an appropriate NEPA analysis will be conducted for each proposed project to evaluate alternatives and select the best course of action.

Table 2 lists some of the high priority projects needed to protect and restore salmon and steelhead habitat on other land ownerships within the Calawah watershed. This is not intended to be a complete list of all remaining restoration work needed on other land ownerships within the watershed. The listed projects simply represent prime opportunities for collaborative restoration.

TABLE 1. REMAINING HIGH AND MODERATE PRIORITY WORK ON NATIONAL FOREST LANDS

RESTORATION TYPE	LOCATION	Miles / Acres /Sites			PRIORITY	ESTIMATED COST	COMMENTS
Decommission / Convert to trail	FS Roads 2912, 2912-040, 045, 050, 060, 063	11.3			High	$ 1,485,000	Decommission; design decommissioning for future use as a trail;
Decommission / Convert to trail	FS Road 29-072 and spurs	3.8			High	$ 486,000	Decommission; design decommissioning for future use as a trail;
Drainage (culverts)	FS Road 2922			10	High	$ 618,240	Replace deteriorating culverts;
Drainage (culverts)	FS Road 29			11	High	$ 1,030,000	Replace deteriorating culverts;
Drainage / Stabilization	FS Road 2922	12.6			High	$350,000	Improve drainage; restore ditchlines, replace d failing culverts; pull back unstable sidecast; install grade sags where appropriate;
Drainage / Stabilization	FS Road 29	36			High	$650,000	Improve drainage; restore ditchlines, replace failing culverts; pull back unstable sidecast; install grade sags where appropriate;
Drainage / Stabilization	FS Road 2923	13.7			High	$210,000	Improve drainage; restore ditchlines, replace failing culverts; pull back unstable sidecast; install grade sags where appropriate;
Drainage / Stabilization	FS Road 2900-030 (Mp 0.0 – 2.0)	2.0			High	$270,000	Continually failing culverts deliver directly to anadromous fish habitat in Hyas Creek.

TABLE 1. REMAINING HIGH AND MODERATE PRIORITY WORK ON NATIONAL FOREST LANDS

RESTORATION TYPE	LOCATION	Miles / Acres /Sites			PRIORITY	ESTIMATED COST	COMMENTS
Decommission	**FS Road 2923-015, 020**	**3.3**			**Moderate / High**	**$ 486,000**	
Decommission	**FS Road 2952-000**	**2.0**			**Moderate / High**	**$ 162,000**	
Pre-commercial thinning, young stands <20 years, in Riparian Reserves	**Sitkum, upper NF Calawah, South Fork Calawah, Albion Creek**		**474**		**Moderate/High**	**$ 75,000**	**Pre-commercial thinning of young forest stands, focusing on stream adjacent riparian areas to improve stand growth for future LWD.**
Level 1 (Storage)	**FS Road 2900-800, 815**	**7.0**			**Moderate/High**	**$ 364,000**	**800 road was partially decommissioned back in 1990's – roads look fairly stable, suggest removing shallow pipes**
Decommission	**FS Road 2900-810**	**1.3**			**Moderate/High**	**$ 162,000**	
Survey abandoned FS roads in Hyas Ridge area to determine risk to aquatic resources	**SF Calawah / Hyas Creek**	**29**			**Moderate / High**	**$20,000**	**Long abandoned roads crossing streams draining into Hyas Creek, may be landslide initiation points.**
Decommission	**FS Road 2922-200, 250, 300**	**2.7**			**Moderate**	**$ 270,000**	**Work may be limited; surveys needed to identify the scope of decommissioning**

TABLE 1. REMAINING HIGH AND MODERATE PRIORITY WORK ON NATIONAL FOREST LANDS							
RESTORATION TYPE	**LOCATION**	**Miles / Acres /Sites**			**PRIORITY**	**ESTIMATED COST**	**COMMENTS**
Level I (Storage)	**FS Road 2922-020**	**0.9**			**Moderate**	**$ 78,000**	**Road bed stable; remove culverts on live stream that deliver to mainstem NF Calawah, put in Level 1**
Level I (Storage)	**FS Road 2929-030**	**1.8**			**Moderate**	**$ 97,500**	**Road bed mostly stable; Bonidu Creek drainage; ATM consider for trail conversion.**
Decommission	**FS Road 2900-030 (MP 2.0 – 3.6)**	**1.6**			**Moderate**	**$ 92,000**	**Need to survey to identify level of work needed – above anadromous reach.**
Level I (Storage)	**FS Road 2900-105**	**0.5**			**Moderate**	**$52,000**	**Major aquatic risk is large culvert on non-fish trib. at end of road**
Total Estimated Cost for Needed Restoration Projects on NF Lands						**$ 6,957,740**	

TABLE 2. REMAINING HIGH PRIORITY WORK ON NON-FOREST SERVICE LANDS							
RESTORATION TYPE	**LOCATION**	**Miles / Acres /Sites**			**PRIORITY**	**ESTIMATED COST**	**COMMENTS**
Develop overwintering pond/habitat for juvenile salmonids	**NF Calawah mainstem**		**2**		**High**	**Rayonier**	
Assess feasibility of constructing engineered log jams in NF Calawah	**NF Calawah mainstem**	**8**			**High**	**Rayonier**	
Survey for noxious weeds along riparian corridors	**Watershed wide**				**High**	**All ownerships**	**Initial knotweed surveys and treatments complete. Continuing need for periodic monitoring and follow-up treatments.**
Work with landowners to identify riparian alder conversion to conifer, for future LWD recruitment	**Watershed wide**				**High**	**All ownerships**	

ALIGNMENT WITH LARGER SCALE MANAGEMENT STRATEGIES

Since the early 1990's watershed restoration within the Calawah watershed has been directed and/or guided by various land management plans, watershed assessments, forest-wide management strategies. Appendix B within the 2009 Sitkum / South Fork Calawah Watershed Restoration Summary (USDA 2010) outlines in chronological order the land management plans, watershed assessments and programs guiding watershed management within the Calawah watershed since the early 1990's.

The Calawah Watershed Aquatic Restoration Plan aligns well with larger scale management efforts including the Olympic National Forest forest-wide management strategies, Forest Service Pacific Northwest Region Aquatic Restoration Strategy, and WRIA 20 salmon restoration plans. The sections below provide a brief summary of how this plan tiers to these key larger scale management strategies.

Olympic National Forest Strategic Plan

In 2004, a team of aquatic, wildlife, silviculture and fire resource managers developed the Olympic National Forest Strategic Plan, a key management tool aimed at integrating projects among different resource areas to accomplish aquatic and terrestrial wildlife restoration objectives. The strategic plan ranked the North Fork Calawah River and South Fork Calawah/ Sitkum River watersheds as high aquatic priorities for restoration, based primarily on the amount of anadromous habitat on national forest system lands within the watersheds and the number of relatively healthy stocks of wild anadromous fish present in the watersheds.

Pacific Northwest Region Aquatic Restoration Strategy

The Forest Service Pacific Northwest Region Aquatic Restoration Strategy is aimed at improvement of watershed and aquatic/riparian habitat conditions at a Regional scale, using a combination of passive and active restoration efforts. Passive restoration is the broad-scale natural recovery of aquatic ecosystems and involves resource support, coordination and analysis and planning/design activities aimed at maintaining or improving habitat conditions. Active restoration involves active intervention (implementation of project activities) specifically designed to influence recovery. The Strategy relies on an increased diverse and close working network of internal and external partnerships.

Under this strategy, the Washington Coastal basin is ranked as a high priority for aquatic restoration. The Olympic National Forest selected the Calawah River watershed as the "Focus Watershed" within the Washington Coastal basin in which to emphasize restoration work. This decision was based in part on its ranking as a high priority watershed in the ONF Strategic Plan and the high level of partnership involvement in restoration through the North Pacific Coast Lead Entity.

Olympic National Forest restoration activities within the Calawah watershed resound well with the purpose of the Pacific Northwest Regional Strategy. Implementation of the Northwest Forest Plan is key to both ongoing passive and active restoration efforts. In addition, Forest

aquatic specialists are actively engaged in coordination, analysis, planning, design and monitoring of projects that promote watershed recovery.

2001 Clean Water Act Memorandum of Agreement

The 2001 U.S. Forest Service Pacific Northwest Region and Washington Department of Ecology (DOE) Clean Water Act Memorandum of Agreement (MOA), is an agreement intent on meeting responsibilities under Federal and State Water Quality Laws. The MOA is aimed at improving water quality throughout the state and recognizes roads as the most significant contributor to water quality degradation within managed forests.

Work identified in this aquatic restoration plan meets the intent of implementation of the Clean Water Act. It emphasizes treatments that remedy of watershed conditions that pose a risk to aquatic resources, including water quality, riparian conditions and beneficial uses.

Westside Forest Water Quality Improvement Plan

The Total Maximum Daily Load (TMDL) process was established by Section 303(d) of the Clean Water Act (CWA). Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards, and to develop Water Quality Improvement Reports to address those pollutants. The TMDL establishes limits on pollutants that can be discharged to the water body and still allow state standards to be met. The Forest Service, Pacific Northwest Region is currently working with the Environmental Protection Agency and Washington Department of Ecology to develop a water quality improvement TMDL for water temperature for national forest system lands on the Gifford Pinchot, Mt. Baker-Snoqualmie and Olympic forests, and will therefore include the Calawah River watershed. The Westside Forest TMDL will address two water bodies listed as degraded on the Clean Water Act 2004 303(d) list for temperature within the Calawah watershed.

Appendix A - Olympic National Forest Road Management Strategy Aquatic Risk Factors

Geologic Hazard

Description of Indicator

The Geologic Hazard Factor uses landslide mapping and certain topographic, materials, and geologic conditions as an indicator of potential future mass wasting and sediment production. In general, this factor identifies those roads located within potentially unstable terrain or within areas with high sensitivity to erosion. In this context it is used primarily as an aquatic habitat and water quality risk factor. This factor evaluates the terrain that the road is located within and not the terrain above the road (refer to the Upslope Hazard Factor for assessment of the latter condition). Therefore, this factor is an indicator of the potential to initiate mass wasting or erosion from roads rather than the potential for impacts to roads from processes initiated upslope. This factor can also be viewed as an indicator for potential damage to the road system, cost of storm damage repair, or as an indicator of high maintenance needs.

The Geologic Hazard Factor and the Proximity (Delivery) to Fish Habitat Factor are weighted the highest among the aquatic risk factors. A numerical geologic hazard score of 3, 6, or 9 is assigned for each road segment as follows:

3 = No portion of the road segment lies within areas identified as high geologic hazard, and less that 30 percent of the road segment length is located within areas identified as moderate geologic hazard.
6 = 0 to 30 percent of the road segment lies within areas identified as high geologic hazard; OR greater than 30 percent of the road segment is located within areas identified as moderate geologic hazard.
9 = 30 percent or more of the road segment is located within areas identified as high geologic hazard.

Units of Indicator

The units are expressed as the percentage of road length within areas identified as low, moderate, or high geologic hazard.

Data Sources

The geologic hazard map was created by combining hazard units from the following Geographic Information System (GIS) map layers: 1) Slope Morphology, 2) Geomorphic Map Units (GMU), 3) Olympic National Forest Cooperative Soil Survey, and, 4) The Geologic Map of the Olympic Peninsula. Units from the slope morphology layer combine steep slope gradients with converging topography (or hollows) and are used as an indicator of potential for shallow rapid landslides and debris flows. Units from the GMU layer include those landforms that have a mass wasting origin, or a high incidence of mass wasting (GMU 70, 71, 72, 74, 77,78, 90 and 91). Units from the Soil Survey layer include mapped landslides, glacial lacustrine (lakebed) deposits, mountain headwalls, and inner gorge landforms. Units from the Geologic Map include

relatively weak bedrock units with a tendency toward large-scale landsliding and/or fine sediment production (Tlct, Tmsl, Ttru, and Ttrm), or mapped landslides (Qls).

Data Limitations

Complete Forest-wide coverage is available for the following data layers: Slope Morphology, Olympic National Forest Cooperative Soil Survey, and The Geologic Map of the Olympic Peninsula. The scale of the Geologic Map of the Olympic Peninsula is 1:125,000. Due to its scale, many existing slope movement features (landslides) are too small to be identified on this map. Therefore, only larger slope movement features are included.

Forest-wide coverage of the Geomorphic Map Units is incomplete. GMU maps have been produced for watershed analysis. Therefore, GMU data, including coverage of known slope movement or landslide features is available for some but not all watersheds. Availability of GMU data is expected to improve in the future as data layers are built and updated.

Proximity (Delivery) to Fish Habitat

Description of Indicator

The Proximity (Delivery) to Fish Habitat Factor combines criteria for sediment delivery efficiency based on landform type and physical distance from the fish bearing portions of the stream network. The purpose of this factor is to provide an estimate of how direct any road effects would be to fish and fish habitat. Direct effects (as defined below) receive high ratings, while indirect effects and moderate ratings are assigned to those areas that may deliver directly to the stream network, but are well upstream of the salmonid fish bearing portions of the network.

Sediment delivery efficiency is rated for all landforms as low, moderate, or high sediment delivery efficiency based on three primary factors: slope gradient, slope shape, and drainage density. Fish bearing streams are determined based on fish distribution data for all salmon species including anadromous and resident (cutthrout trout) salmonids. In order to connect landforms to the salmonid fish bearing portion of the stream network a proximity or distance factor was applied. For roads within moderate sediment delivery efficiency landforms, a distance of 150 feet was used to indicate a direct connection. For roads and streams within high sediment delivery efficiency landforms, a distance of 2,250 feet was used to indicate a direct connection.

The Proximity (Delivery) to Fish Habitat Factor and the Geologic Hazard Factor are weighted the highest among the aquatic risk factors. A numerical score of 3, 6, or 9 is assigned for each road segment as follows:

3 = Road segment is located within low sediment delivery efficiency landforms.
6 = Road segment is located within moderate or high sediment delivery efficiency landforms but the fish habitat is not, or it is further than 2,250 feet from fish habitat (at the nearest point).
9 = Both the road segment and the fish bearing stream are located within high sediment delivery efficiency landforms; AND 10 percent or more of the road segment is located within these

areas; AND the road is within 2,250 feet of fish habitat; OR the road is located in a moderate sediment delivery efficiency landform and is closer than 150 feet from fish habitat.

Units of Indicator

The rating is assigned as low, moderate or high based on the highest rating given for greater than 10 percent of the road segment.

Data Sources

Sediment delivery efficiency is rated for all landforms on the Forest as a part of the Olympic National Forest Ecological Unit Inventory (EUI). Landforms are rated low, moderate, or high sediment delivery efficiency based primarily on three factors: slope gradient, slope shape, and drainage density.

Fish distribution data taken from the Olympic National Forest GIS coverage was used to identify fish bearing streams. Fish distribution included data for all salmon species anadromous and resident (cutthrout trout) salmonids.

To develop a direct connectivity of high sediment delivery landforms to fish bearing streams, a distance of 2,250 feet was applied. This value was used because in a population of 410 landslides and debris flows identified in three watersheds on the Olympic Peninsula, 80 percent of all mass wasting features ran out within 2,250 feet from the initiation site.

Discrete pathways, such as debris flow run-out models or 1st and 2nd order streams were not used to develop criteria for this factor.

Stream Crossing Density

Description of Indicator

The Stream Crossing Density Factor determines the relative hazard associated with stream crossings within the road segment. This factor is defined in terms of the frequency of stream crossings per road mile for each road segment. Frequency values are generated from GIS based on the number of times a stream segment intersects the road segment. A numerical rating for the stream crossing density factor is assigned to each road segment based on the following criteria:

0 = Road segment has no stream crossings.
1 = Road segment has a density of 1 to 2 stream crossings per road mile.
2 = Road segment has a density of 3 to 4 stream crossings per road mile.
3 = Road segment has a density which exceeds 4 stream crossings per road mile.

Units of Indicator

The units for stream crossing density are expressed as the number of stream crossings per road mile for each road segment.

Riparian Zone – Stream Proximity

Description of Indicator

The Riparian Zone – Stream Proximity Factor determines the relative degree of connectivity between the road system and the stream system. This factor is related to the portion of the road segment within the riparian zone or in close proximity to a stream. For this factor, riparian zones are defined as a 100-meter buffer width, which spans both sides of the channel, as measured from the center of the channel (50 meters either side of the stream). Values are generated from GIS based on the portion of road segment that intersects the riparian zone. A numerical rating for riparian zones is assigned to each road segment using the following criteria:

0 = Road segment has no road miles within the riparian zone.
2 = 1 to 33 percent of the road segment is within the riparian zone.
4 = 34 to 66 percent of the road segment is within the riparian zone.
6 = 67 to 100 percent of the road segment is within the riparian zone.

Unit of Indicator

This indicator is based on the percentage of road segment within 50 meters of the stream.

Upslope Hazard

Description of Indicator

The Upslope Hazard factor identifies those roads located downslope of steep converging topography or terrain designated to have a high potential for landslides. Impacts to both the road and the aquatic system often occur in areas with upslope hazard conditions. These hazard elements may initiate new hillslope failures or increase the magnitude of initial mass wasting events. Roads selected with this factor are often those with the highest frequency of storm damage. Culvert “blow outs”, dam break floods, debris torrents, diversions and cascading failures are the types of mechanisms often associated with these hazard conditions. Geologic (landslides, debris flows, etc.) and hydrologic (peak flow) hazards may both be factors in this type of environment. Traditional peak flow factors (percent of area in the rain-on-snow zone combined with hydrologically immature vegetative condition) were considered for this factor by ultimately not utilized.

The area above the road that is considered to have high geologic hazard and a well-defined pathway is used to make this assessment. The definition for geologic hazard for this factor is the same one used in the Geologic Hazard Factor. However, this factor differs from the Geologic Hazard Factor in that the road itself may not be on terrain that is considered hazardous, and the problems/disturbances affecting the road or the aquatic system may not be initiated from the road itself. Well-defined pathways are defined as steep 1st, 2nd (or 3rd) order streams with gradients in excess of 15 percent that connect upslope areas of geologic hazard with the road below.

A numerical rating for upslope hazard is assigned to each road segment using the following criteria:

0 = Road segment has no terrain upslope rated as high geologic hazard that is connected to the road through a well-defined pathway.
1 = Road segment has < 1 acre of terrain upslope that is rated as high geologic hazard and is connected to the road through a well-defined pathway.
2 = Road segment has 1 to 10 acres of terrain upslope that is rated as high geologic hazard and is connected to the road through a well-defined pathway.
3 = Road segment has > 10 acres of terrain upslope that is rated as high geologic hazard and is connected to the road through a well-defined pathway.

Unit of Indicator

This indicator is based on the area above and connected to the road that is considered to have high geologic hazard conditions.

Aquatic Risk Factor Composite Rating

A composite rating of low, moderate, high and very high was assigned to each road segment based on combining values of the aquatic risk factors. Two methods were utilized to determine a final rating. Method 1 developed a cumulative aquatic score, given a sum total of all risk factors. The lowest possible score within the aquatic matrix is 6, the highest is 30, and the range of points is 23. Threshold scores were established by dividing the possible range the cumulative scores into thirds. Each category assigned this way has a range of 8 to 9. Method 2 based the rating on the combination of Geologic Hazard Factor and Proximity (Delivery) to Fish Habitat Factor. Method 2 does not include rating based on the other three aquatic risk factors. Road segments with high ratings for both factors were assigned a high composite aquatic rating. The composite rating of aquatic risk for each road segment is therefore based on the following criteria:

Low = Road segment has a combined numerical value that ranges from 6 to 14.
Moderate = Road segment has a combined numerical value that ranges from 15 to 22.
High = Road segment has combined values from the Geologic Hazard Factor and Proximity (Delivery) to Fish Habitat Factor rating equal to or greater than 15.
Very high = Road segment has a combined numerical value that ranges from 23 to 30.

For the purposes of combining groups of factors (aquatics, access, silviculture and wildlife, etc.), the high and very high categories are combined and considered to be a high concern for aquatic resources.

Appendix B - Forest Service Road Maintenance Levels

The following excerpt taken from the Forest Service Handbook 7709.58 Transportation System Maintenance Handbook provides descriptions objective maintenance levels 1-4.

Level 1- Assigned to intermittent service roads during the time they are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance is performed to keep damage to adjacent resources to an acceptable level and to perpetuate the road to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are "prohibit" and "eliminate."

Roads receiving level 1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for nonmotorized uses.

Level 2 - Assigned to roads open for use by high clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level. Appropriate traffic management strategies are either to (1) discourage or prohibit passenger cars or (2) accept or discourage high clearance vehicles.

Level 3 - Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities.

Roads in this maintenance level are typically low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users.

Level 4 - Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times.