WRIA 21 Queets/Quinault
Salmon Habitat Recovery Strategy

Prepared by the

WRIA 21 Lead Entity[1]

2011 Edition

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WRIA 21 Queets/Quinault
Salmon Habitat Recovery Strategy

1.0 Introduction

The purpose of this document is to describe the elements of a strategic action framework for guiding the development and prioritization of salmonid habitat recovery projects for Watershed Resource Inventory Area (WRIA) 21. The document updates and builds on previous versions of the strategy, most recently the one submitted in 2010 (WRIA 21 Lead Entity 2010). This strategy will serve a number of functions, including the following:

- To guide the identification, prioritization, and development of salmonid habitat recovery actions and assessments for funding through the Salmon Recovery Funding Board (SRFB);
- To recruit project sponsors and to guide their attention towards higher priority geographic areas, issues, and actions;
- To enlist the support and participation of landowners and communities in the region to improve and strengthen efforts to restore and protect salmonid habitat;
- To serve as a vehicle for community education and outreach;
- To seek other sources of project funding to augment SRFB funds.

The last section of the document (Section 7) provides specific steps for applying the material contained herein in project development.

WRIA 21 (Figure 1) encompasses an area of 755,674 acres along the Pacific coast of the Olympic Peninsula from Kalaloch Creek in the north to Connor Creek in the south. It includes the watersheds of the Queets/Clearwater, Quinault, Moclips, Raft, and Copalis Rivers, plus several small streams that flow directly into the Pacific Ocean. These watersheds encompass parts of the Olympic Mountains and their foothills, which are drained by the largest rivers in the WRIA, as well as an extensive coastal plain that empties through many streams and rivers to the Pacific Ocean. Also included are marine shorelines encompassing approximately 65 miles.

The aquatic habitats within the WRIA are extremely diverse, created by its varied topography and geology, forested landscape, glacial history, and the seasonally heavy runoff patterns of the Olympic Rain Forest. The area is drained by some of the last remaining free-flowing large rivers in the lower 48 states, and contains a large contiguous area of undisturbed habitat in the Olympic National Park (ONP). Prior to about 1850, the entire area below timberline was covered by a primeval coastal forest with immense western red cedar, Sitka spruce, Douglas fir, and western hemlock. Today, the aquatic and riparian habitats in WRIA 21 include areas that are relatively pristine as well as areas that have been greatly affected by logging and other land-use activities over the last century.

The large majority of the old-growth trees outside ONP were removed from WRIA 21 between approximately 1920 through the 1980s due to timber harvest and land-clearing. The timing and rate of timber harvest varied between different areas and watersheds in the region. These events had significant effects on floodplain forest regeneration cycles and quality and quantity of salmon habitat over this time period, many of which were the subject of extensive research and documentation (e.g. Osborn 1971; Cederholm et al. 1976; Zasoski et al. 1977; Cederholm et al. 1978; Fender and Dilley 1979; Lestelle and Blum 1989; Capoeman 1990; Smith and Caldwell 2001; Fetherston 2005; Herrera and QDFi 2008; USBOR 2005). Much of the salmon habitat today within WRIA 21, except for areas well into the interior of ONP, remains in a degraded state.

Significant acreage is owned by various governments and large forest landowners that have natural resource management responsibilities. These include the Quinault Indian Nation, Olympic National Park, Olympic National Forest, Department of Natural Resources, and private forest landowners. In addition, there are other federal, state, and county governments with management authority. The entire WRIA constitutes a portion of the QIN Usual and Accustomed Fishing and Hunting Area. Additional jurisdictions located in the area are the U.S. Fish and Wildlife Maritime Refuge and the NOAA Olympic Coast National Marine Sanctuary.

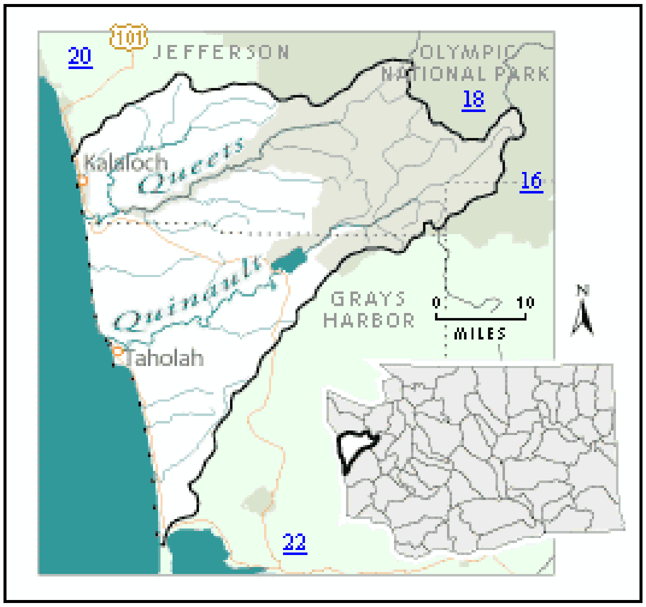

Figure 1. The WRIA 21 geographic area.

The largest rivers of WRIA 21 have always been known as the home of great salmon and steelhead runs—with abundance and especially large fish. The runs have supported the Quinault tribal people (including Queets people) from time immemorial—the importance of which continues to the present. The fish are also highly valued in the non-tribal communities within the WRIA, as well as to those in the greater region. All of the salmon and steelhead species and races that are native to Washington State are produced in WRIA 21 streams.[2] It is known, or can

[2] / Chinook (spring, summer, and fall races), coho, chum, sockeye, and pink salmon, as well as cutthroat trout, steelhead (summer and winter races), and native char (bull trout / Dolly Varden) are produced in the waters of WRIA 21. Pink salmon are found only in very small numbers and are not included as part of the stock list in this document.

be inferred, that the salmon and steelhead runs are much reduced from their historic production levels due to the history of land-use practices (Lestelle and Blum 1989; Herrera and QDFi 2008).

The habitat-related issues that have threatened, and continue to threaten, the salmonid stocks within the WRIA have all generally been related to forest harvest and land clearing, but another growing issue is climate change. This issue, which is particularly relevant to the stocks produced in the upper parts of the two large rivers fed by high elevation areas in the WRIA, is also considered as part of the strategic action plan.

The following sections describe elements of an overall strategy for salmon habitat restoration and protection in WRIA 21. Application of this overall strategy is expected to gradually restore salmon populations and the integrity of natural processes upon which they rely. However, salmon restoration in WRIA 21 will not be complete until our vision is achieved (Section 2.0.)

The document is organized into seven sections:
1. Introduction;
2. Vision;
3. Guiding principles and approach;
4. Salmonid stock prioritization;
5. Watershed and action prioritization;
6. The way forward; and
7. Literature cited.

2.0 Vision

The vision for WRIA 21 salmonid habitats is as follows:

> *All of the watersheds in WRIA 21 contain healthy, diverse populations of salmon sustained by healthy ecosystems that are supported by undisrupted physical and biological processes, and contain abundant, contiguous aquatic, near shore, estuarine, and riparian habitats utilized by diverse, species-rich biological communities that support and service the cultural and other value-based needs of local stakeholders.*

Contained within this vision statement is an understanding that modern society often causes changes in watershed processes and functions. Still, in WRIA 21 watersheds, ecological processes can be maintained—or restored to normative functions—sufficiently to support productive salmon life histories adapted to them. Normative refers to the norms of ecological functions and processes characteristic of salmon-bearing streams—it takes into account the normal range of variation that existed historically within which the salmon populations adapted and thrived. These features, when balanced with society’s needs, can result in an ecosystem in which both natural and cultural elements can exist in a balance, allowing salmon to thrive and many of society’s present uses of the river to continue, although not without modification in many cases (Liss et al. 2006).

Habitat recovery strategies needed for WRIA 21 are largely intended to promote restoration of disrupted natural processes and protect those that remain intact. These strategies aim to restore a normative range of processes and functions, not to restore pre-altered conditions.

2.1 Mission

The Technical and Citizen Review Groups (or Committee) formulated the mission statement for the WRIA 21 Lead Entity in 2002 to be the following:

> *Our mission is to protect and restore physical and biological processes that benefit naturally spawning salmonids and their habitats.*

To fulfill this mission, the WRIA 21 Lead Entity seeks to identify credible and fundable habitat restoration, protection, and enhancement projects. In doing so, resulting projects and related programs and activities are expected to produce sustainable and measurable benefits for salmon habitats and for the human communities within and near the WRIA 21 region.

2.2 Goals

The terms "normative processes" and "normative function" are incorporated into this strategy to mean an altered system that has a balanced mix of natural and cultural features such that indigenous life histories of salmon populations can be supported at a productive level. Liss et al. (2006) described the normative ecosystem within a salmon recovery context as follows:

> *"We need a view of an ecosystem as a dynamic mix of natural and cultural features that typify modern society, but that can still sustain all life stages of a diverse and productive suite of salmonid populations if the essential ecological conditions and processes necessary to maintain the populations still exist within the ecosystem. We call this ecosystem, with its balanced mix of natural and cultural features, a 'normative' ecosystem."*

The essential element of what constitutes "normative" in this context is that the level of restored ecosystem processes and functions must be able to support and sustain productive salmon life histories that can provide both ecologically and culturally derived values.

Goals and sub-goals for restoring, protecting, and enhancing salmon habitat conditions within WRIA 21 are listed below. Three goal statements are presented, one each for restoration, protection, and habitat enhancement. A fourth goal is also presented, which operates in conjunction with the other three—it emphasizes the need for a collaborative process for engaging governmental agencies, institutions and stakeholders in working together to achieve the other three goals. Each goal is followed by sub-goals that provide greater specificity for targeting actions. Specific measurable objectives associated with these goals have not been formulated.[3]

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[3] / An approach for defining habitat recovery targets to achieve specific levels of fish population performance for salmon and steelhead populations has not yet been generally accepted in the Pacific Northwest. EDT modeling is one method that is being used in some watersheds (e.g., Thompson et al. 2009; R. Brocksmith, Hood Canal

1. Restore normative ecological processes and functions of the WRIA 21 watersheds associated with all of their aquatic habitats that directly or indirectly support salmonid species.
    a. Restore upland landscapes, including rates of sediment delivery, land cover structure, and vegetation species composition, to support normative watershed processes, functions, and forms.
    b. Restore floodplain functions and normative patterns of connectivity and channel switching within WRIA 21 river corridors, with particular attention being given to the upper Quinault River floodplain corridor.
    c. Restore normative fluvial geomorphic processes through the channel corridors to restore channel form and function and normative sediment processing patterns.
    d. Restore normative flow regimes to WRIA 21watersheds, especially in regards to rates of runoff and intermediate flood peaks.
    e. Restore accessibility of native salmonids to their historic ranges of habitat use in WRIA 21 watersheds.
    f. Restore normative levels of nutrient loading, particularly associated with marine-derived nutrients, within WRIA 21 watersheds.
    g. Restore estuarine and near-shore processes and habitats.

2. Protect ecological processes and functions of the WRIA 21 watersheds associated with all of their aquatic habitats that directly or indirectly support salmonid species.
    a. Protect floodplain corridors from further loss of connectivity between mainstem rivers and their overflow channels, side channels, and off-channels.
    b. Protect riparian corridors from further degradation by safeguarding native vegetation species, riparian forest age, and riparian forest structure.
    c. Protect water quality from further degradation from non-point and point pollution sources.
    d. Protect from further loss aquatic habitat structure, including wood structure, edge structure, and the distribution and composition of habitat types.
    e. Protect from further degradation the structural elements that contribute to near-shore habitat forming processes and associated key habitats.

3. Enhance[4] environmental conditions as needed within WRIA 21 watersheds to facilitate recovery and/or safeguarding salmonid life histories and stock genetics for the strengthening or protection of stock productivity.
    a. Improve accessibility to off-channel habitats that have high natural inter-annual variability in accessibility, while protecting native wildlife species and abundance.

Coordinating Council, personal communications) but consensus on its use does not exist. Also, WRIA 21 habitats have not characterized for use with EDT.

[4] / The term "enhance" is used in this document to mean the enhancement of habitat in a way that did not exist in the natural state of the watershed. It involves some kind of intervention to promote improved survival of natural produced salmon, or in one case, the use of engineering to build artificial habitats for the sake of safeguarding the existing genetic structure of a natural population while natural habitat remedies are being sought.

   b. Create and use artificial habitats using technological advances in salmon propagation to safeguard genetic resources of a stock at risk, while longer-term solutions using natural habitat remedies are sought.[5]

4. Establish a collaborative framework for coordinating restoration, protection, and enhancement activities within the watersheds for facilitating improvements in salmonid habitat conditions and related stock performance.
   a. Promote and maintain effective coordination between all parties engaged in habitat restoration, protection, and enhancement within the WRIA 21 region.
   b. Hold periodic conferences and workshops to share information on progress of restoration and enhancement activities, research and monitoring results, revisions to watershed plans, and other related activities. Locations for these events will include, but not be limited to, Taholah, Lake Quinault, and Queets/Clearwater.
   c. Develop and implement innovative ways of interaction, outreach, and education with the public to strengthen partnerships and participation in habitat restoration and protection.
   d. Conduct at least two briefings annually for the Citizen Committee. These would include an early preview of the coming year's SRFB projects being considered, and a midsummer presentation of those SRFB projects that were selected to be requested for funding.
   e. Groups to be included in the annual briefings are: QIN Land and Natural Resources Committee, county commissioners or their representatives, landowners, citizen clubs, WA DNR RMAP coordinator, and Technical Review Group members.

2.3 Measuring Success

The ultimate measure of success of efforts to recover salmon habitats will be the performance of the fish populations of interest. Population performance is evaluated using the four viable salmonid population (VSP) parameters: abundance, productivity, life history diversity, and spatial structure (McElhany et al. 2000). However, the evaluation of population performance is a long-term endeavor, requiring annual collection of run size and distribution metrics that for many of the salmon stocks in WRIA 21 are not currently being assessed. Data collection efforts are not expected to be increased appreciably in the near-term, at least for most stocks. It is also recognized that even with consistent, annual assessments, the ability to conclude that a performance response has been significantly improved generally requires at least 20 years of data given natural variation that occurs and sampling error rates (e.g., Lichatowich and Cramer 1979). Moreover, many habitat restoration actions will require relatively long time periods for effects to mature and benefit the populations (such as through the re-growth of a healthy riparian forest).

Given the long-time periods needed to evaluate salmon population response, a more appropriate and meaningful measure of success in the shorter-term is simply to employ implementation monitoring. This means that the actions have been confirmed to have taken place successfully and that the specified level of implementation for each action was achieved (e.g., number of road

[5] / Achieving this sub-goal would involve use of captive brood technology.

miles were properly abandoned, acres of knotweed were controlled, number of log structures were installed, etc.). Confirmation of implementation will be the standard measure of success. Somewhat longer-term measures of success, that might require special funding, would be effectiveness monitoring to determine how effective actions have been at achieving intermediate objectives (e.g., log-structures placed in the Upper Quinault River are successful at stabilizing key channels and reforming vegetated islands).

2.4 Socio-Economic Factors that Limit or Support the Vision and Goals

This action plan has been formulated recognizing that a variety of socio-economic factors will influence the extent that actions can be successfully implemented. These factors are listed below, along with activities that can be pursued to improve chances for success.

Limiting Socio-Economic Factors

- A number of the residents within WRIA 21 and in nearby communities oppose the acquisition of property by conservation organizations and governmental agencies for conservation purposes.
- Conservation actions that might affect the profitability of the forest-based industries of WRIA 21 and adjacent lands could potentially impact some residents and the communities in general.
- Conflicting perceptions exist within some communities about the compatibility of certain human activities with salmonid productivity.
- Concerns can exist in some communities about potential effects of increased large wood debris and jams resulting from restoration actions on the safety of river users.
- Perceptions sometimes exist that the potential benefits of restoration actions do not justify the costs of some habitat related actions.
- Lack of understanding can exist within communities about the options for habitat restoration and salmonid performance without harming the economic base.
- Fears can exist about possible future encumbrances on land owners and river users associated with recovery projects.
- Budgetary constraints at the federal, state, and local levels have made it more difficult to secure needed funds for priority projects.

Supporting Socio-Economic Factors

- Actions to restore stable, vegetated islands can be especially helpful to stabilize the Upper Quinault River channels and protect adjacent private property.
- The unstable nature of the current state of the Upper Quinault River is a threat to private property and the infrastructure of the Upper Quinault Valley community. Climate change patterns could exacerbate this condition.
- The most harmful logging activities to fish habitat occurred during a past era when little concern existed about adverse effects of logging. Logging technologies have since been significantly improved—modern logging practices are much more compatible with maintaining quality fish habitat than they were previously.

- Many residents of WRIA 21 and nearby communities are wholly or partially dependent on a healthy tourism industry and benefit from visitors drawn to the area for fishing and other outdoor recreational activities. The WRIA 21 area is a popular destination for sport fishing enthusiasts and outdoor recreationists in the Pacific Northwest.
- Tribal commercial fishing and guiding on tribal sections of rivers in WRIA 21 rivers are major sources of livelihood within the tribal communities; these activities are reserved by treaty with the U.S. government. Tribal fishing is also important culturally to the tribal communities.
- Many non-tribal residents of WRIA 21 and nearby communities place high value on being able to fish—and catch fish—recreationally in WRIA 21 streams.
- Private property and small forest landowners have access to programs to help fund riparian improvement efforts.
- Some residents of WRIA 21 communities support appropriate acquisition and conservation easement creation by conservation and governmental agencies in cooperation with willing landowners.
- Major landholdings within WRIA 21 are under management by the federal government, Washington State, and the Quinault Nation, all of whom support salmon recovery initiatives.
- Conditions of acquisitions by conservation organizations (such as recently occurred in the lower Clearwater River subbasin in the Queets watershed by The Nature Conservancy) include provisions for continuation of normal tax revenues to local governments.
- Lands acquired by conservation organizations (such as recently occurred in the lower Clearwater River subbasin in the Queets watershed by The Nature Conservancy) can provide for logging-related economic benefits to be derived from those lands.
- Opportunities exist for residents of WRIA 21 and nearby communities to be engaged in habitat recovery projects in WRIA 21, and thereby benefit economically.

<u>Measures to Address Limiting Factors</u>

- Develop an information exchange and dialogue forum between tribal, state, and federal natural resource agencies and the principal community centers in WRIA 21 to routinely share information related to fish populations/fish habitat issues of potential interest to residents.
- Implement innovative ways of interaction, outreach, and education between fish habitat managers and conservation entities and the public to develop partnerships and participation in habitat restoration and protection.
- Publicize progress of successful habitat projects; hold periodic conferences and workshops to share information on progress of restoration activities.
- Perform and publicize comprehensive project planning, design, and cost benefit of major projects, soliciting public input prior to final design and project planning.
- Encourage project sponsors and contractors to maximize use of local companies, workers, and supplies in project implementation to provide economic benefit to communities.
- Publicize how land acquisitions by conservation organizations (such as recently occurred in the lower Clearwater River subbasin in the Queets watershed by The Nature Conservancy) do not impact tax revenues to local governments.

- Publicize how lands acquired by conservation organizations (such as recently occurred in the lower Clearwater River subbasin in the Queets watershed by The Nature Conservancy) can provide for logging-related economic benefits in the future.

2.5 Current State of Scientific Knowledge that Limits or Supports the Vision and Goals

This action plan has been formulated based on information collected on the lands and waters of WRIA 21 over the past 40 years. Much of this information is contained in project reports and published documents (some of which has been peer reviewed). While a lot is known about many of the streams and their fish populations, there is also much that is not known or that is uncertain. Moreover, much information is out of date, reflecting conditions that existed in the 1970s or 1980s. The information that is available, or its lack, serves either to support the actions that have been outlined herein or to limit the types and extent of those actions that still need to be identified. This section identifies scientific knowledge that either limits or supports the development of appropriate actions. Informational items that limit action development are data gaps that remain to be addressed.

Limiting State of Scientific Knowledge

- *Current State of Aquatic Habitats*:
  - Quantitative assessments of habitat conditions have not been made in the Queets system since the mid-1990s; quantitative assessments have never been made in many of the other watersheds.
  - Qualitative assessments were made in many Quinault, Raft, and Camp Creek watersheds in the 1970s.
  - Recent work has been done in parts of the lower Quinault watershed to assess the extent of invasive knotweeds (and probably some parts of the Clearwater drainage). No assessments have been made in major portions of the WRIA.

- *Fish Passage Effectiveness at Road Crossings*:
  - Data are lacking on fish passage issues in Joe Creek and Copalis River.
  - Some parts of the Queets, and perhaps Kalaloch Creek, are also lacking fish passage assessments.
  - A full culvert analysis was recently been completed on the Quinault Reservation.

- *Access to Off-Channel Habitats*:
  - Little or no assessment work has been performed on much (or all) of the lower Quinault watershed, nor in the Raft, Moclips, and Copalis watersheds, nor in the other smaller, independent streams that enter directly into the Pacific Ocean.
  - Assessments are also lacking on parts of the Queets system, though they have been done in the Clearwater drainage.

- *Opportunities for Creating New Off-Channel Habitats*:
  - Identification of opportunities for creating new off-channel habitats has been made in the Clearwater drainage; they are lacking for the remainder of the WRIA.

- *Riparian Corridor Condition*:
    - It is uncertain how up to date riparian assessments are for large parts of the WRIA. (Watershed analyses on the Salmon River, Raft River, and Quinault River watersheds contain useful information.)

- *Road System Conditions*:
    - It is uncertain how up to date road condition assessments are for large parts of the WRIA.

- *Spawning, Rearing, and Overwintering Habitat Distribution*:
    - Habitat distribution data for spawning, rearing, and overwintering habitats are best for the Queets system where there is much documented. Information for the Quinault watershed is more qualitative, with the notable exception for data in the upper Quinault system, particularly as it applies to sockeye.
    - These types of data are largely lacking for the other watersheds.

- *Fish Distribution*:
    - Information on salmonid distribution is largely lacking for large parts of the Raft, Moclips, and Copalis watersheds, as well as in the smaller independent drainages.
    - Distribution information is quite good in most of the Queets and Quinault watersheds.

- *Quantitative Limiting Factors Analysis*:
    - The limiting factors analysis (LFA) done by Smith and Caldwell (2001) provided a qualitative review of factors that are likely important to salmonid stocks in most parts of the WRIA.
    - No quantitative LFAs have been done with the exception of one in the Clearwater River by Dominguez (2006) using the EDT model. Lestelle (2009) provided some information on limiting factors at a macro scale for coho in the Queets watershed.

- *Effects of Climate Change Patterns on Population Distribution and Performance*:
    - No assessments have been made to determine the effects of climate change and associated glacier recession on habitats and fish stocks in the Queets and Quinault watersheds.

- *Fish Population Abundance*:
    - Partial assessments are made annually of spawning escapements of coho, fall Chinook, spring/summer Chinook, and winter steelhead in the Quinault watershed. The sampling design is not suitable for estimates of precision.
    - A complete assessment is made annually of the sockeye escapement in the Quinault watershed.

- Complete assessments are made annually of spawning escapements of coho, fall Chinook, spring/summer Chinook, and winter steelhead in the Queets watershed, though the assessments for fall species have suffered in some recent years due to extreme weather conditions. The sampling design is not suitable for estimates of precision.
- No assessments are made for escapements of other species in the Queets and Quinault watersheds, or for any species in the other WRIA 21 watersheds.
- Annual estimates are made for coho smolt yields in the Queets and Clearwater watersheds. No other estimates are made of smolt yields for any other stocks in the WRIA.

- *Genetic Structure of Stocks of Concern*:
    - Nothing is known about genetic stock structure of the spring/summer Chinook populations (in conjunction with fall Chinook) and how the stocks genetically maintain stock differentiation spatially and temporally. This is also the true for the Quinault sockeye population.
    - An understanding of stock differentiation characteristics would be extremely helpful in habitat recovery planning for the sake of locating and sequencing projects. It is also needed if some sort of interventions is needed to safeguard genetics while habitat projects are progressing over some period of years.

- *Nutrient Limitations*:
    - Studies have been carried out in Lake Quinault and in various streams in the Queets and Quinault watersheds to assess nutrient limitations. The Lake Quinault assessments were influenced by extreme variation in fine sediment inputs into the lake during winter flows.
    - Additional work is needed in both the lake and in streams to assess limitations given the degree of interannual variation that occurs.

<u>Supporting State of Scientific Knowledge</u>

- *Diagnosis for Causes of Decline of Quinault Sockeye and Changes in Upper Quinault River*:
    - A comprehensive diagnosis has been made for the Quinault sockeye population through the collaborative work of QIN, Herrera Environmental, and the Bureau of Reclamation. See Table 7 for citations.
    - The diagnosis served as the basis for formulating a scientifically driven plan for restoring the Upper Quinault watershed for sockeye recovery. The plan will also aid other salmonid populations in the upper watershed, notably spring/summer Chinook.

- *Successful Creation of Logjam Structures and Stable Islands*:
    - The restoration plan for the Upper Quinault watershed is based on comprehensive studies of how logjams can be restored both for the sake of fish production and for the protection of private property.

- Numerous case studies exist in the Pacific Northwest to demonstrate the benefits of rebuilding logjams for both fish production and private property protection.

- *Extensive and Intensive Evaluations of Effects of Logging on WRIA 21 Streams and Fish Populations*:
  - Intensive and extensive studies were carried out in the 1970s in the Clearwater watershed and on the Quinault Reservation to assess the impacts of logging on the fisheries resources produced there. See Table 7 for citations. These studies provided significant information on limiting factors as well as in ways of ameliorating effects.
  - More recent analysis of fish production in the Queets River strongly suggest that habitat conditions have continued to deteriorate in the Clearwater watershed, pointing towards certain types of actions (see Lestelle 2009).

- *Watershed Analyses*:
  - Watershed analyses have been completed on many of the watersheds in WRIA 21, notably on portions of the Queets system (including in Salmon River), and in the Quinault and Raft River watersheds.

- *Fish Population Abundance Information for Certain Populations*:
  - Quantitative stock abundance data exists on many of the Queets River populations, portions of many of the Quinault populations, and for Quinault sockeye.
  - Estimates of run size and escapement of Quinault sockeye extend back in time many decades.

- *Declines in Abundances of Spring/Summer Chinook*:
  - Spawning escapement estimates for Queets spring/summer Chinook cover the period from the late 1970s to the present. The pattern indicates that the run has declined sharply and may be approaching the point of depensation (where decline may accelerate).
  - While there is uncertainty about all of the causes of decline, most indicators suggest that a de-stabilization of spawning habitats is likely a primary factor. (It is noted that harvest rates on the population have likely declined sharply since the 1970s—they have essentially been eliminated in-river.)
  - Similar patterns are believed to exist for Quinault River spring/summer Chinook.

- *Changes in Coho Smolt Yield Distributions Related to Land Uses*:
  - Estimates of coho smolt yields in Queets system, annually assessed since the early 1980s, are broken into estimates of the number of smolts emigrating from overwintering ponds and from pool-riffle tributaries. The data indicate a shift toward increasing pond contribution and decreasing tributary contribution to the overall yield, believed to be due to declining habitat quality in the tributaries (Lestelle 2009).

  - These findings suggest that certain types of restoration projects would be beneficial in the tributaries, as well as a need to also improve the availability and accessibility of off-channel ponds.

- *Juvenile Coho Life History Studies in the Queets River System*:
  - Very extensive studies that date to the 1970s have documented the diversity of various coho life history tactics on the Olympic Peninsula and their importance in population dynamics (see citations in Table 7).
  - These studies provide guidance for habitat restoration, protection, and enhancement projects.

- *Culvert Inventories*:
  - A complete inventory was made of culvert condition and fish passage issues on the Quinault Reservation over the past three years.

- *Successful Creation of Off-Channel Habitats and Improvements in Coho Performance*:
  - Numerous studies, some cited in Table 7, demonstrate the significant benefits that can be gained to coho populations by improving access to off-channel ponds and creating additional ponds.

- *Knotweed Proliferation and Control Measures*:
  - Invasive knotweeds have become established in many, if not all, WRIA 21 watersheds. These plants can cause adversely affect the quality of riparian corridors, in turn affecting to the quantity and quality of salmon habitat.

- *Glacial Recessions in Queets and Quinault River Headwaters*:
  - Very significant recession of the major glaciers and snowfields that feed the upper Queets and Quinault rivers have receded over the past 80 years. These changes have doubtlessly caused some changes in late summer flow and water temperature in reaches used by spring/summer Chinook and bull trout.
  - Evidence also points towards changes in sediment dynamics in the upper reaches of these rivers, which is also likely relevant to the future performance of these species.

- *Success of Measures to Safeguard Genetic Resources of ESA Listed Populations*:
  - There is cause for concern that the time period needed to address habitat issues for spring/summer Chinook and Quinault sockeye may be such that genetic components of the runs might be lost while efforts are progressing.
  - Several projects conducted elsewhere (e.g., Dungeness River, White River, Snake River) demonstrate that small facilities (serving as artificial habitats) can be built to rearing salmonids to adulthood for spawning. These projects have been completely successful at protecting genetic resources while habitat issues are being addressed. See citations in Table 7.
  - Similar methods may be necessary to safeguard the genetic resources of Queets and Quinault spring/summer Chinook and Quinault sockeye.

- *Successful Measures to Address Nutrient Limitations*:
  - Nutrient enhancement is an action type identified to be potentially very beneficial in WRIA 21.
  - Numerous studies demonstrate the benefits of nutrient enhancement (see citations in Table 7).

3.0 Guiding Principles and Approach

This section presents a set of principles and an approach for prioritizing the salmonid stocks and their habitat areas for recovery actions within the WRIA 21 region. The principles are then used to define scoring criteria for prioritization purposes. No single principle in itself is to be used for guiding prioritization—it is the combination of elements associated with each that is used in formulating the approach for prioritization.

Bull trout is the only salmonid species within the WRIA listed under the Endangered Species Act (listed as threatened). Although WDFW (1998) lists four watersheds within the WRIA as having distinct stocks (Queets, Quinault, Moclips, and Copalis) of native char (bull trout and Dolly Varden), it is likely that the species is only produced in two of these river systems, i.e., the Queets and Quinault rivers (see footnote 3 and related text). Available information strongly suggests that native char populations are relatively stable and abundant within WRIA 21 (based on WDFW 1998 and observations by Quinault tribal biologists). Given that their spawning habitats are largely (or even entirely) protected within Olympic National Park, opportunities to address habitat restoration through the WRIA 21 strategy are extremely limited. Therefore, the principles and criteria outlined below do not give added deference to this species in formulating recovery strategies.

3.1 Guiding Principles

Eight principles were identified on which to base prioritization of stocks and their habitats for recovery actions:

1. Higher priority for recovery actions should be directed at stocks that are in greatest need of habitat improvements based on long-term trends in abundance, risk of further loss or risk of suffering from low abundance demographic effects, and their current status relative to historic performance.

2. Higher priority should be given to stocks that are not supported in part by on-going hatchery production and supplementation—stocks without hatchery supplementation are solely reliant on habitat condition for their existence and performance status.

3. Higher priority should be given to stocks for which information on performance and limiting factors is most certain, i.e., greater uncertainty exists about need and potential outcome for stocks having a high level of uncertainty about status and limiting factors.

4. Higher priority should be given to stocks where the certainty of success associated with projects is higher than for stocks with unknown or less certainty of success.

5. Higher priority should be given to stocks that likely have a higher ecological significance to the stability and vitality of terrestrial and aquatic ecosystems.

6. Higher priority should be given to stocks that are biologically more unique in the watershed, in WRIA 21, or in the greater region of the Olympic Peninsula coast compared to other stocks in those areas—this considers the extent of loss in life history and genetic diversity that would occur if a stock was extirpated.

7. Higher priority should be given to stocks that have special importance to either the tribal culture within WRIA 21 or to non-tribal cultures in the same region.

8. Higher priority should be given to stocks that provide the most economic benefits to the communities within WRIA 21 or in nearby communities.

3.2 Approach to Prioritization

An approach was developed for scoring each salmonid stock in WRIA 21 using a set of criteria that addresses each of the principles identified above. The criteria were simple and relatively easy to apply in scoring each stock based on information available for the stock, or that can generally be inferred from various studies in the region, or on the observations of resource agency staff personnel made in past years. Nine aspects of each stock were scored with the criteria given in Table 1, as listed below:

1. Stock status (expected or known);
2. Hatchery fish contribution;
3. Certainty of knowledge about status and limiting factors;
4. Certainty of success with focused actions;
5. Ecological significance;
6. Biological uniqueness;
7. Tribal cultural significance;
8. Non-tribal social significance; and
9. Economic significance.

The scoring levels for each criterion were given a numeric score numbering (shown in Table 1) between 0-3, or 0-4 if the additional level was warranted for that criterion. The levels were ordered so that a low score would have least effect on stock prioritization and a high score would have the greater effect. All stocks were scored for all criteria.

The sums of the scores provided a straightforward way of prioritizing all stocks relative to one another. Criteria numbered 5-9 in the list above (i.e., those addressing an aspect of significance, hence referred to in this document as the “significance criteria”) were first averaged, then the average value for those five criteria was added to the sum of the scores for the other criteria to produce a total score for each stock. The significance criteria were also scored in two ways for each stock, the first being with regard to significance within the stock’s natal watershed and the second with regard to the significance to the entire WRIA.[6] Thus, a given stock might have a low score compared to other stocks in the WRIA, but it could have a high score compared to other stocks in its natal watershed. Scoring in this way provided a way of identifying the highest priority stock for each watershed, as well as for identifying priorities over the entire WRIA.

This scoring procedure also provided a simple way to prioritize watersheds for recovery planning based on the total of scores accrued for each watershed associated with the stocks present there. In addition, it gives guidance in identifying appropriate strategies for targeting specific stocks. Specific reaches or tributaries are not prioritized in this document, though such information can be added at a future time based on identifying core spawning and/or rearing areas associated with each stock.

[6] / The criterion for economic significance also took into account in a very general way the economic impact that a stock could have on a geographic area outside the boundaries of the WRIA. For example, Queets River coho can be controlling stock on PFMC-regulated ocean fisheries north of Cape Falcon in northern Oregon. Thus, this stock can have a very significant impact under some conditions on economic benefits derived from ocean fisheries off the coast of Washington.

Table 1. Scoring criteria for prioritizing salmonid stocks for recovery actions.

Stock status (expected or known)	
Score	Description
0	Comparable to historic abundance and stability
1	Unknown
2	Diminished abundance but stable over long-term
3	Long-term decline; heightened concern
4	Abundance small and in long-term decline; stock of concern
Hatchery contribution	
Score	Description
1	Large influence
2	Intermediate influence
3	Negligible to stock performance
Certainty of knowledge about status and limiting factors	
Score	Description
1	Low certainty
2	Intermediate certainty
3	High certainty
Certainty of success with focused actions	
Score	Description
1	Low certainty
2	Intermediate
3	High certainty
Ecological significance	
Score	Description
0	Unknown
1	Small component of aquatic community; likely low significance
2	Intermediate or widely variable component of aquatic community--considered to have intermediate significance
3	Large component of aquatic community; likely high significance or likely a keystone species
4	Likely keystone species having especially unique habitats within watershed
Biological uniqueness	
Score	Description
0	Unknown
1	Little or no particular unique characteristics believed to exist compared to other nearby stocks
2	Diverse life histories known or suspected to exist providing an intermediate level of uniqueness
3	Highly unique life histories and/or genetic characteristics
Tribal cultural significance	
Score	Description
0	Unknown
1	Low significance known to exist to tribal culture
2	Average significance to tribal culture
3	Higher significance than most salmon runs
4	Especially high significance to tribal culture
Non-tribal social significance	
Score	Description
0	Unknown
1	Low significance expected to non-tribal society
2	Average significance
3	Higher than average significance
4	Especially high significance to non-tribal culture
Economic significance	
Score	Description
0	Unknown
1	Low relative significance
2	Intermediate relative significance
3	High relative significance

4.0 Salmonid Stock Prioritization

The prioritization of all salmonid stocks known or likely to be present in each of the watersheds of WRIA 21 is presented in this section.

4.1 Stocks

A total of 56 stocks was identified to exist within WRIA 21, based on how stocks were delineated in WDFW and WWTIT (1994), WDFW (1998), WDFW (2000), and Smith and Caldwell (2001), in addition to some splitting to account for likely stock differentiation between fish produced upstream and downstream of Lake Quinault (Table 2).

It should be noted that there is some inconsistency in how WDFW and WWTIT (1994), i.e., the Salmon and Steelhead Stock Inventory (SASSI) system, and Smith and Caldwell (2001) delineated stocks, with the latter generally combining a species in the Queets River system between the Clearwater and Queets subbasins, whereas the former generally separated them. Past versions of the WRIA 21 habitat strategy generally followed that of Smith and Caldwell (2001) by combining them. For the sake of this updated version, it was decided to use whichever classification produced the greatest degree of distinction since this provides more resolution in scoring and in assigning strategies to each stock.[7] It was also recognized that there is very likely a level of stock differentiation for those species produced upstream and downstream of Lake Quinault due to an effect of the lake on how spawners are able to home to natal streams. It seems likely that the lake serves to produce a greater level of differentiation than occurs between the Clearwater and Queets (upstream of Clearwater) rivers.

It is further noted that there exists some uncertainty on whether there are self-reproducing stocks of native char (bull trout / Dolly Varden) in the Moclips and Copalis rivers. WDFW (1998) delineated these fish as separate stocks based on this statement: "They have been caught by anglers in the anadromous zone (Bill Freymond, WDFW, personal communications." It should be noted that there is no evidence of actual spawning by native char in these rivers. The work of Brenkman and Corbett (2005) appears to have resolved this uncertainty. They found on the basis of radiotelemetry that bull anadromous bull trout that spawn in the upper Hoh River will move between watersheds along coastal Washington for purposes of foraging and winter refuge. Some fish that appear to have been natal to the Hoh River, for example, were found to move to lower Kalaloch Creek, Queets River, and Raft River for non-spawning purposes. Bull trout spawning habitats appear to be located in the very upper reaches of the larger, glacially-fed, rivers on the Washington coast.

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[7] / It is important to recognize that the separation of a Queets system stock into two stocks as done in SASSI has no bearing on how the entirety of the population in that river system is managed for fisheries. Population units for fisheries management are based on a long history of principles and practices recognized by the federal court through *U.S. vs. Washington*. This is also true for Quinault stocks differentiated on the basis of being produced either upstream or downstream of Lake Quinault.

Table 2. Salmonid stocks produced in the WRIA 21 watersheds. The table also identifies those stocks that were specifically listed as stocks in the system referred to as the Salmon and Steelhead Stock Inventory (SASSI). Stock codes shown are those used in Figure 2. Table is continued to next page.

Watershed	Species	Stock	SASSI stock?	Stock code
Kalaloch Cr	Coho	Kalaloch Cr coho	Yes	Kal_Coho
	Steelhead	Kalaloch Cr winter steelhead	Yes	Kal_WSth
	Cutthroat	Kalaloch Cr cutthroat		Kal_Cutt
Queets R	Chinook	Queets R spr/sum Chinook	Yes	Qts_SChin
		Clearwater R spr/sum Chinook	Yes	Clear_SChin
		Queets R fall Chinook	Yes	Qts_FChin
		Clearwater R fall Chinook	Yes	Clear_FChin
	Coho	Queets R coho	Yes	Qts_Coho
		Clearwater R coho	Yes	Clear_Coho
		Salmon R coho	Yes	Sal_Coho
	Chum	Queets R chum		Qts_Chum
	Steelhead	Queets R summer steelhead	Yes	Qts_SSth
		Clearwater R summer steelhead	Yes	Clear_SSth
		Queets R winter steelhead	Yes	Qts_WSth
		Clearwater R winter steelhead	Yes	Clear_WSth
	Cutthroat	Queets R cutthroat	Yes	Qts_Cutt
	Bull trout	Queets R bull trout / Dolly Varden	Yes	Qts_Bull
Whale Cr	Cutthroat	Whale Cr cutthroat		Wha_Cutt
Raft R	Coho	Raft R coho	Yes	Raft_Coho
	Steelhead	Raft R winter steelhead	Yes	Raft_WSth
	Cutthroat	Raft R cutthroat	Yes	Raft_Cutt
Camp Cr	Coho	Camp Cr coho		Camp_Coho
	Cutthroat	Camp Cr cutthroat		Camp_Cutt
Duck Cr	Cutthroat	Duck Cr Cutthroat		Duck_Cutt
Quinault R	Chinook	Upper Quinault R spr/sum Chinook	Yes [1/]	UQuin_SChin
		Lower Quinault R spr/sum Chinook	Yes [1/]	LQuin_SChin
		Upper Quinault R fall Chinook	Yes [1/]	UQuin_FChin
		Lower Quinault R fall Chinook	Yes [1/]	LQuin_FChin
		Cook Cr fall Chinook	Yes	Cook_FChin
	Chum	Upper Quinault R chum	Yes [1/]	UQuin_Chum
		Lower Quinault R chum	Yes [1/]	LQuin_Chum
	Coho	Upper Quinault R coho	Yes [1/]	UQuin_Coho
		Lower Quinault R coho	Yes [1/]	LQuin_Coho
		Cook Cr coho	Yes	Cook_Coho
	Sockeye	Quinault R sockeye	Yes	Quin_Sock
	Steelhead	Quinault R summer steelhead	Yes	Quin_SSth
		Upper Quinault R winter steelhead	Yes	UQuin_WSth
		Lower Quinault R winter steelhead	Yes	LQuin_WSth
	Cutthroat	Quinault R cutthroat	Yes	Quin_Cutt

Watershed	Species	Stock	SASSI stock?	Stock code
	Bull trout	Quinault R bull trout / Dolly Varden	Yes	Quin_Bull
Wreck Cr	Coho	Wreck Cr coho		Wrk_Coho
	Steelhead	Wreck Cr winter steelhead		Wrk_WSth
	Cutthroat	Wreck Cr Cutthroat	Yes	Wrk_Cutt
Moclips R	Coho	Moclips R coho	Yes	Moc_Coho
	Steelhead	Moclips R winter steelhead	Yes	Moc_WSth
	Cutthroat	Moclips R cutthroat	Yes	Moc_Cutt
	Bull trout	Moclips R bull trout / Dolly Varden	Yes	Moc_Bull
Joe Cr	Coho	Joe Cr coho		Joe_Coho
	Steelhead	Joe Cr winter steelhead		Joe_WSth
	Cutthroat	Joe Cr Cutthroat	Yes	Joe_Cutt
Copalis R	Coho	Copalis R coho	Yes	Cop_Coho
	Steelhead	Copalis R winter steelhead	Yes	Cop_WSth
	Cutthroat	Copalis R cutthroat	Yes	Cop_Cutt
	Bull trout	Copalis R bull trout / Dolly Varden	Yes	Cop_Bull
Conner Cr	Coho	Conner Cr coho		Con_Coho
	Cutthroat	Conner Cr cutthroat	Yes	Con_Cutt

1/ SASSI did not split this Quinault River stock into upper and lower Quinault stocks as it did for winter steelhead, but the presence of Lake Quinault likely serves to maintain some level of stock differentiation.

4.2 Stock Prioritization

Scores for each of the scoring criteria were assigned to each stock in each watershed, shown in two parts: Table 3 for the criteria not related to stock significance and Table 4 for significance criteria. Table 4 also shows the scores for each of the five significance criteria at the watershed and WRIA geographic scales, as well as the average values across all five criteria at both geographic scales. Table 5 gives the total scores (summed for all criteria) for each criterion at the watershed and WRIA geographic scales. It also presents the total scores standardized on a numeric scale of 1-4. The total scores were standardized to the 1-4 numeric scale to make it simpler to compare scores for the reader. On the standardized scale, a value of 4 is the highest score that a stock could get and a value of 1 was the lowest. Note that within a single watershed one stock (or more than one with ties) would receive a score of 4 and one stock (or more than one with ties) would be assigned a value of 1.

Figure 2 presents the scoring results for all stocks at the WRIA scale arranged from lowest to highest score. Stock priorities were divided into five tiers based on the pattern of results to facilitate planning. Tier 1 consisted of the top nine stocks. Tier 2 consisted of the next 13 highest scoring stocks.

Table 3. Prioritization scoring for WRIA 21 stocks using criteria not related to stock significance. Dark green highlighting indicates the highest score within each criterion, yellow indicates the lowest. Table is continued to next page.

Watershed	Stock	Status	Hatchery contrib	Knowledge certainty	Success certainty
Kalaloch Cr	Kalaloch Cr coho	2	3	1	2
	Kalaloch Cr winter steelhead	2	3	1	2
	Kalaloch Cr cutthroat	2	3	1	2
Queets R	Queets R spr/sum Chinook	4	3	2	2
	Clearwater R spr/sum Chinook	4	3	2	2
	Queets R fall Chinook	2	3	2	2
	Clearwater R fall Chinook	2	3	2	2
	Queets R coho	2	3	3	3
	Clearwater R coho	2	3	3	3
	Salmon R coho	2	1	2	2
	Queets R chum	1	3	1	1
	Queets R summer steelhead	3	3	1	1
	Clearwater R summer steelhead	3	3	1	1
	Queets R winter steelhead	2	3	2	2
	Clearwater R winter steelhead	2	3	2	2
	Queets R cutthroat	2	3	1	2
	Queets R bull trout / Dolly Varden	2	3	1	1
Whale Cr	Whale Cr cutthroat	2	3	1	2
Raft R	Raft R coho	2	3	1	2
	Raft R winter steelhead	2	3	1	2
	Raft R cutthroat	2	3	1	2
Camp Cr	Camp Cr coho	2	3	1	2
	Camp Cr cutthroat	2	3	1	2
Duck Cr	Duck Cr Cutthroat	2	3	1	2
Quinault R	Upper Quinault R spr/sum Chinook	4	3	2	2
	Lower Quinault R spr/sum Chinook	4	3	2	2
	Upper Quinault R fall Chinook	2	2	2	2
	Lower Quinault R fall Chinook	2	2	2	2
	Cook Cr fall Chinook	2	1	2	2
	Upper Quinault R chum	1	3	1	2
	Lower Quinault R chum	2	2	2	2
	Upper Quinault R coho	2	3	2	3
	Lower Quinault R coho	2	3	2	3
	Cook Cr coho	2	1	2	3
	Quinault R sockeye	3	3	3	3
	Quinault R summer steelhead	3	3	1	1

Watershed	Stock	Status	Hatchery contrib	Knowledge certainty	Success certainty
	Upper Quinault R winter steelhead	2	2	2	2
	Lower Quinault R winter steelhead	2	3	2	2
	Quinault R cutthroat	2	3	1	2
	Quinault R bull trout / Dolly Varden	2	3	1	1
Wreck Cr	Wreck Cr coho	2	3	1	2
	Wreck Cr winter steelhead	2	3	1	2
	Wreck Cr Cutthroat	2	3	1	2
Moclips R	Moclips R coho	2	3	1	2
	Moclips R winter steelhead	2	3	1	2
	Moclips R cutthroat	2	3	1	2
	Moclips R bull trout / Dolly Varden	1	3	1	1
Joe Cr	Joe Cr coho	2	3	1	2
	Joe Cr winter steelhead	2	3	1	2
	Joe Cr Cutthroat	2	3	1	2
Copalis R	Copalis R coho	2	3	1	2
	Copalis R winter steelhead	2	3	1	2
	Copalis R cutthroat	2	3	1	2
	Copalis R bull trout / Dolly Varden	1	3	1	1
Conner Cr	Conner Cr coho	2	3	1	2
	Conner Cr cutthroat	2	3	1	2

Table 4. Prioritization scoring for WRIA 21 stocks using the five significance criteria. Each stock was scored compared to other stocks within its natal watershed and again compared against all stocks within the WRIA. Average values across all five criteria are also shown. Dark green highlighting indicates the highest score within each criterion, yellow indicates the lowest. Table is continued to next page.

Stock	Ecological significance		Biological uniqueness		Tribal cultural significance		Non-tribal social significance		Economic significance		Ave	Ave
	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA
Kalaloch Cr coho	3	2	2	2	2	1	2	1	2	1	2.2	1.4
Kalaloch Cr winter steelhead	2	1	2	2	2	1	2	1	2	1	2	1.2
Kalaloch Cr cutthroat	2	1	2	1	1	1	2	1	2	1	1.8	1
Queets R spr/sum Chinook	3	3	3	3	3	3	3	3	1	1	2.6	2.6
Clearwater R spr/sum Chinook	3	3	3	3	3	3	3	3	1	1	2.6	2.6
Queets R fall Chinook	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Clearwater R fall Chinook	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Queets R coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Clearwater R coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Salmon R coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Queets R chum	1	1	2	2	1	1	1	1	1	1	1.2	1.2
Queets R summer steelhead	2	3	3	3	1	2	3	3	1	1	2	2.4
Clearwater R summer steelhead	2	3	3	3	1	1	3	3	1	1	2	2.2
Queets R winter steelhead	3	3	2	2	2	2	3	3	3	3	2.6	2.6
Clearwater R winter steelhead	3	3	2	2	2	2	3	3	3	3	2.6	2.6
Queets R cutthroat	2	1	2	1	1	1	2	2	1	1	1.6	1.2
Queets R bull trout / Dolly Vard.	2	2	3	3	1	1	1	1	1	1	1.8	1.8
Whale Cr cutthroat	3	1	2	1	1	1	1	1	1	1	1.6	1
Raft R coho	3	2	2	2	2	2	1	1	2	1	2	1.6
Raft R winter steelhead	3	2	2	2	2	2	1	1	2	1	2	1.6
Raft R cutthroat	2	1	2	1	1	1	1	1	1	1	1.4	1
Camp Cr coho	3	1	2	2	2	1	1	1	1	1	1.8	1.2
Camp Cr cutthroat	3	1	2	1	1	1	1	1	1	1	1.6	1
Duck Cr Cutthroat	3	1	2	1	1	1	1	1	1	1	1.6	1
Up. Quinault R spr/sum Chinook	3	3	3	3	3	3	3	3	1	1	2.6	2.6
Low. Quinault R spr/sum Chinook	3	3	3	3	3	3	2	2	2	2	2.6	2.6
Up. Quinault R fall Chinook	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Low. Quinault R fall Chinook	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Cook Cr fall Chinook	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Upper Quinault R chum	2	2	2	3	2	2	1	1	2	2	1.8	2
Lower Quinault R chum	3	3	2	3	2	2	1	1	2	2	2	2.2
Upper Quinault R coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Lower Quinault R coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Cook Cr coho	3	3	2	2	2	2	2	2	3	3	2.4	2.4
Quinault R sockeye	4	3	4	4	4	4	2	2	3	2	3.4	3
Quinault R summer steelhead	2	3	3	3	1	1	3	3	1	1	2	2.2
Up. Quinault R winter steelhead	3	3	2	2	2	2	3	3	3	3	2.6	2.6
Low. Quinault R winter steelhead	3	3	2	2	2	2	3	3	3	3	2.6	2.6
Quinault R cutthroat	2	1	2	1	1	1	2	2	1	1	1.6	1.2
Quinault R bull trout / Dolly Vard.	2	2	3	3	1	1	1	1	1	1	1.8	1.8
Wreck Cr coho	3	1	2	2	2	1	1	1	1	1	1.8	1.2

Stock	Ecological significance		Biological uniqueness		Tribal cultural significance		Non-tribal social significance		Economic significance		Ave	Ave
	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA	Water-shed	WRIA
Wreck Cr winter steelhead	3	1	2	1	2	1	1	1	1	1	1.8	1
Wreck Cr Cutthroat	2	1	2	1	1	1	1	1	1	1	1.4	1
Moclips R coho	3	2	2	2	2	2	2	2	2	2	2.2	2
Moclips R winter steelhead	3	2	2	2	2	2	2	1	2	1	2.2	1.6
Moclips R cutthroat	2	1	2	1	1	1	2	2	2	1	1.8	1.2
Moclips R bull trout / Dolly Vard.	1	1	3	3	1	1	1	1	1	1	1.4	1.4
Joe Cr coho	3	2	2	2	2	1	2	2	2	1	2.2	1.6
Joe Cr winter steelhead	3	1	2	1	2	1	1	1	1	1	1.8	1
Joe Cr Cutthroat	2	1	2	1	1	1	2	2	2	1	1.8	1.2
Copalis R coho	3	2	2	2	2	2	2	2	2	2	2.2	2
Copalis R winter steelhead	3	2	2	2	2	2	2	1	2	1	2.2	1.6
Copalis R cutthroat	2	1	2	1	1	1	2	2	2	1	1.8	1.2
Copalis R bull trout / Dolly Vard.	1	1	3	3	1	1	1	1	1	1	1.4	1.4
Conner Cr coho	3	1	2	2	2	1	1	1	1	1	1.8	1.2
Conner Cr cutthroat	2	1	2	1	1	1	1	1	1	1	1.4	1

Table 5. Total scores accrued to each stock at the watershed scale and WRIA scale. Scores are also shown standardized to a 1-4 numeric score. Dark red highlighting indicates the highest score within related to each geographic scale and white highlighting the lowest. Table is continued to next page.

Watershed	Stock	Total score		Standardized to 1 - 4	
		Watershed	WRIA	Watershed	WRIA
Kalaloch Cr	Kalaloch Cr coho	10.2	9.4	4.0	1.8
	Kalaloch Cr winter steelhead	10	9.2	2.5	1.8
	Kalaloch Cr cutthroat	9.8	9	1.0	1.7
Queets R	Queets R spr/sum Chinook	13.6	13.6	4.0	3.5
	Clearwater R spr/sum Chinook	13.6	13.6	4.0	3.5
	Queets R fall Chinook	11.4	11.4	3.0	2.6
	Clearwater R fall Chinook	11.4	11.4	3.0	2.6
	Queets R coho	13.4	13.4	3.9	3.4
	Clearwater R coho	13.4	13.4	3.9	3.4
	Salmon R coho	9.4	9.4	2.0	1.8
	Queets R chum	7.2	7.2	1.0	1.0
	Queets R summer steelhead	10	10.4	2.3	2.2
	Clearwater R summer steelhead	10	10.2	2.3	2.2
	Queets R winter steelhead	11.6	11.6	3.1	2.7
	Clearwater R winter steelhead	11.6	11.6	3.1	2.7
	Queets R cutthroat	9.6	9.2	2.1	1.8
	Queets R bull trout / Dolly Varden	8.8	8.8	1.8	1.6
Whale Cr	Whale Cr cutthroat	9.6	9	4.0	1.7
Raft R	Raft R coho	10	9.6	4.0	1.9
	Raft R winter steelhead	10	9.6	4.0	1.9
	Raft R cutthroat	9.4	9	1.0	1.7
Camp Cr	Camp Cr coho	9.8	9.2	4.0	1.8
	Camp Cr cutthroat	9.6	9	1.0	1.7
Duck Cr	Duck Cr Cutthroat	9.6	9	4.0	1.7
Quinault R	Up. Quinault R spr/sum Chinook	13.6	13.6	3.2	3.5
	Low. Quinault R spr/sum Chinook	13.6	13.6	3.2	3.5
	Up. Quinault R fall Chinook	10.4	10.4	1.7	2.2
	Low. Quinault R fall Chinook	10.4	10.4	1.7	2.2
	Cook Cr fall Chinook	9.4	9.4	1.3	1.8
	Upper Quinault R chum	8.8	9	1.0	1.7
	Lower Quinault R chum	10	10.2	1.5	2.2
	Upper Quinault R coho	12.4	12.4	2.6	3.0
	Lower Quinault R coho	12.4	12.4	2.6	3.0
	Cook Cr coho	10.4	10.4	1.7	2.2
	Quinault R sockeye	15.4	15	4.0	4.0
	Quinault R summer steelhead	10	10.2	1.5	2.2
	Up. Quinault R winter steelhead	10.6	10.6	1.8	2.3
	Low. Quinault R winter steelhead	11.6	11.6	2.3	2.7
	Quinault R cutthroat	9.6	9.2	1.4	1.8
	Quinault R bull trout / Dolly Varden	8.8	8.8	1.0	1.6
Wreck Cr	Wreck Cr coho	9.8	9.2	4.0	1.8
	Wreck Cr winter steelhead	9.8	9	4.0	1.7
	Wreck Cr Cutthroat	9.4	9	1.0	1.7
Moclips R	Moclips R coho	10.2	10	4.0	2.1
	Moclips R winter steelhead	10.2	9.6	4.0	1.9

Watershed	Stock	Total score		Standardized to 1 - 4	
		Watershed	WRIA	Watershed	WRIA
	Moclips R cutthroat	9.8	9.2	3.6	1.8
	Moclips R bull trout / Dolly Varden	7.4	7.4	1.0	1.1
Joe Cr	Joe Cr coho	10.2	9.6	4.0	1.9
	Joe Cr winter steelhead	9.8	9	1.0	1.7
	Joe Cr Cutthroat	9.8	9.2	1.0	1.8
Copalis R	Copalis R coho	10.2	10	4.0	2.1
	Copalis R winter steelhead	10.2	9.6	4.0	1.9
	Copalis R cutthroat	9.8	9.2	3.6	1.8
	Copalis R bull trout / Dolly Varden	7.4	7.4	1.0	1.1
Conner Cr	Conner Cr coho	9.8	9.2	4.0	1.8
	Conner Cr cutthroat	9.4	9	1.0	1.7

The Quinault River sockeye stock received the highest score for habitat restoration of the 56 stocks scored (Figure 2). It received the highest possible scores for all criteria except for three. Stock status was assigned a value of 3 (4 being the highest possible), meaning that the stock has been in a long-term decline and has heightened concern about its performance. Only the spring/summer Chinook stocks in the Queets and Quinault rivers were assigned a status level of 4 (meaning that abundances are low, the stocks are in a long-term decline, and they are stocks of concern). The other two criteria for Quinault sockeye not given the highest score possible were for social significance to non-tribal cultures and for economic benefit to the WRIA. It bears noting that the Quinault sockeye is a population of special significance ecologically and biologically, as well having utmost significance to the Quinault Tribe, both historically and currently (Capoeman 1990).

The top 22 priority stocks of the 56 stocks in the WRIA are produced in the Quinault and Queets rivers. Fours stocks tied for second highest priority—the two spring/summer Chinook stocks in each of the Quinault and Queets rivers. The two coho stocks in the Queets watershed (Queets and Clearwater River coho) scored with the third highest scores.

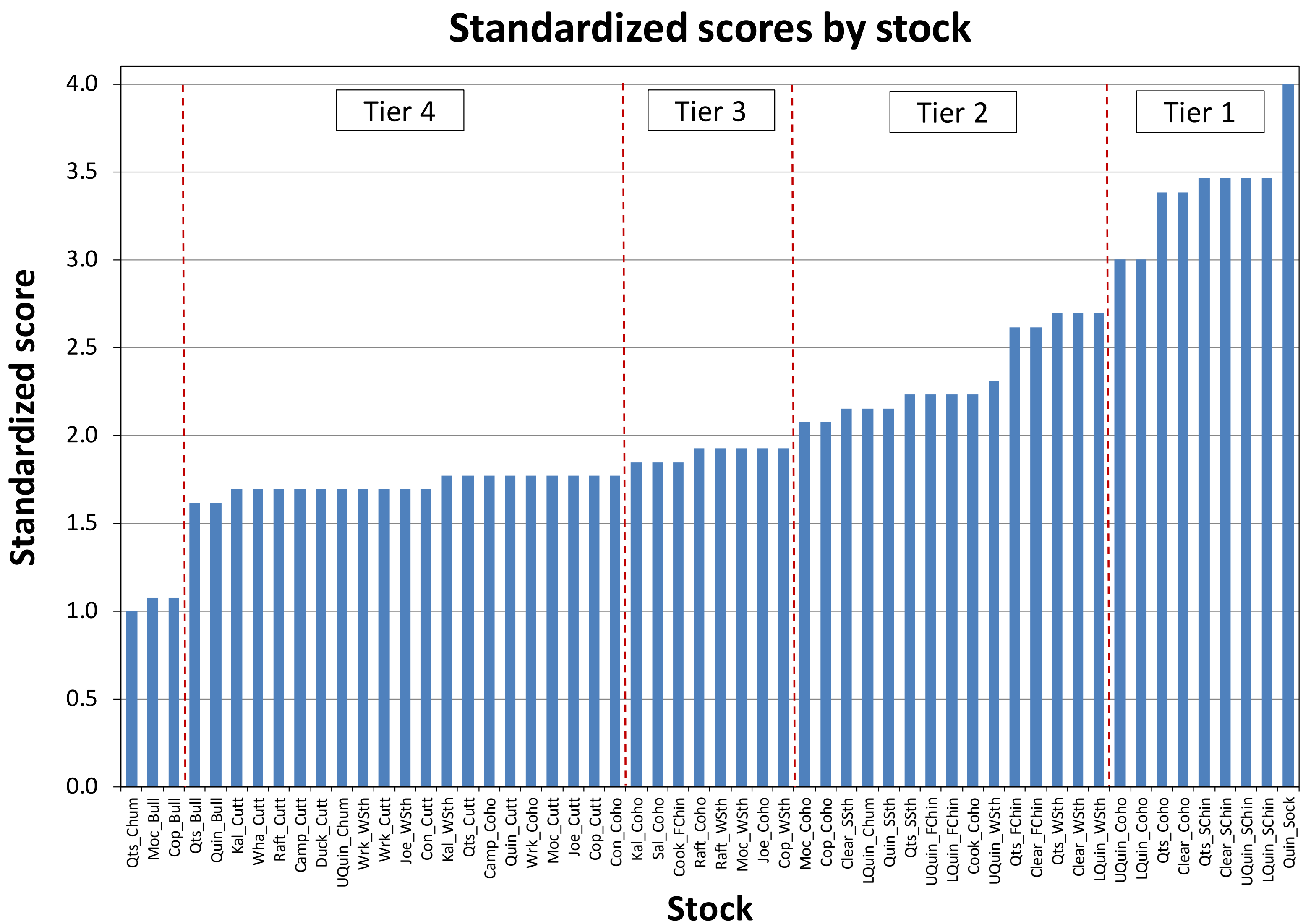


Figure 2. Prioritization of the 56 WRIA 21 stocks, shown using scores standardized to a 1-4 numeric scale with 4 having the highest priority and 1 having the lowest. See Table 2 for a list of stock codes.

5.0 Watershed and Action Prioritization

This section provides guidance on how watersheds should be prioritized for actions, the issues that need to be targeted for those actions, and specific actions for project development.

5.1 Watershed Prioritization

The results of the stock prioritization provide the basis for prioritizing watersheds within WRIA 21 for targeting habitat-related actions. A total score for each watershed was derived by summing up the total scores for each stock in each watershed, here using scores standardized with the 1-4 numeric scale (Table 6). Figure 3 displays the scoring for the watersheds arranged by their north-south location along the coast.

These results indicate that the highest priority for habitat-related actions should be given to the Queets and Quinault watersheds, followed by the Raft, Moclips, and Copalis watersheds, then by the smaller watersheds (in the order shown by their total scores for small watersheds). The scoring generally tracked with the size of watersheds.

Table 6. The number of salmonid stocks and the sum of their total scores for each WRIA 21 watershed. The scores fall into major groups, which also correspond with the relative sizes of the watersheds.

Relative size	Watershed	Size (mi^2)	No. stocks	Total score
Large	Queets	450	14	34.9
	Quinault	434	16	39.8
Medium	Raft	93	3	5.5
	Moclips	39	3	5.8
	Copalis	41	3	5.8
Small	Kalaloch	21	3	5.3
	Whale		1	1.7
	Camp		2	3.5
	Duck		1	1.7
	Wreck		3	5.2
	Joe		3	5.4
	Conner		2	3.5

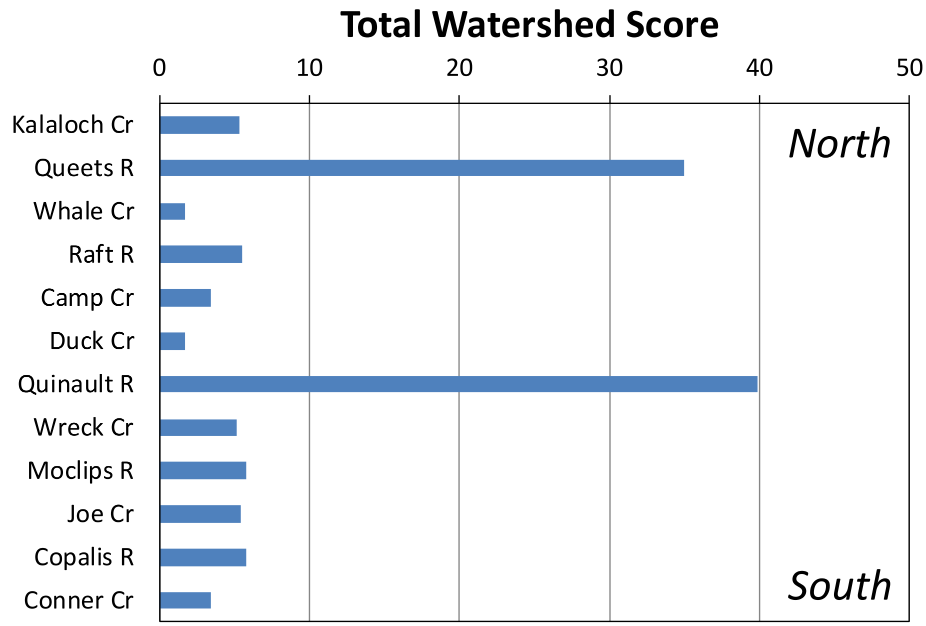


Figure 3. Watershed scores for WRIA 21 watersheds shown arranged by their north-south location along the Washington coast.

5.2 Major Habitat Issues Identified

The basis for identifying habitat-related actions for WRIA 21 watersheds is documented in Table 7. The table provides a logic structure that begins with identification of the major habitat-related issues in the WRIA and a short description of each issue. The sequence in the logic structure then identifies the relevance of the issue to salmonids, the root causes of the issue, likely solutions, and a list of actions for realizing those solutions. Information sources are also listed. Twelve issues that encompass the factors that adversely affect the performance or future sustainability of the stocks were identified, listed below:

1. Access to in-stream habitats;
2. Access to off-channel habitats;
3. Large stream floodplains and channel conditions;
4. Climate change patterns and conditions in large rivers;
5. Small stream floodplains and channel conditions;
6. Riparian conditions;
7. Sediment loading;
8. Water quality conditions;
9. Flow regime characteristics;
10. Lake habitats conditions;
11. Low nutrient levels in streams and Lake Quinault; and
12. Restoration timescale.

5.3 Action Identification and Prioritization

A total of 46 habitat-related actions, including related assessments, were identified for addressing the twelve issues listed above. These actions provide the necessary guidance for identifying specific projects for implementing those actions.

The applicability of each action to each stock was identified by designating an applicability rating as follows:

- High applicability
- Medium or moderate applicability
- Low applicability
- Not applicable

The results of these applicability ratings are shown color coded (with numeric codes also) in Figure 3 for all 52 stocks. These results give guidance for selecting the most applicable strategies to target habitat-related recovery actions for each stock.

Additional guidance related to each action is given by considering three aspects of an action in project development. These three aspects are:

- The amount of time (or years) that will be needed for a project to realize full benefits to restoring salmon habitat;
- The relative expected effectiveness of an action for addressing an issue; and
- The relative geographic scale over which an action would need to be applied to realize full effectiveness to address an issue.

Each of these aspects for each action was defined using a rating of 1, 2, or 3, as shown in Table 8. The results of applying these ratings are given in Table 9 for all actions.

The next section of this document provides a set of steps and questions for giving guidance in developing projects based on the material presented above.

Table 7. Habitat-related issues that adversely affect the performance or sustainability of salmonid stocks within WRIA 21. A logic structure is presented for identifying actions to address each issue. Table is continued to multiple pages.

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
Access to in-stream habitats: Poorly designed culvert installations and old culverts (and other old stream-crossing structures) in disrepair can block or impede passage of juvenile and/or adult salmonids moving upstream for rearing or spawning. For example, a recently completed culvert inventory and assessment on the Quinault Reservation identified over 400 culverts that impede salmonid passage in some fashion. Affected watersheds: ▪ All, but particularly a problem on the coastal plain in areas logged longer than 20 years ago (lower Queets, Whale, Raft, Camp, Duck, lower Quinault, Wreck, Moclips, Copalis systems).	▪ Access to spawning and/or rearing habitat can restrict the amount of stream able to be used by salmonid populations. ▪ Restricted access reduces the capacity of WRIA 21 streams for salmonid production. ▪ Issue mainly affects species reliant on small tributaries for spawning and rearing (i.e., coho, winter steelhead, and cutthroat).	▪ Poorly designed culvert installations can cause perched outfalls, resulting in passage restrictions. ▪ Old culverts can collapse or become plugged, restricting fish access. ▪ Old culverts on small streams with rusted and leaking bottoms can restrict passage due to limited flow during base flow. ▪ Collapsed and debris-jammed old stringer bridge crossings can restrict fish access.	▪ Remove stream crossing structures on abandoned or closed roads. ▪ Redesign and rebuild stream crossing structures to accommodate flows and fish passage.	▪ Assess stream crossing structures for fish passage effectiveness (assessment completed in 2011 on the Quinault Reservation). ▪ Remove stream crossing structures on closed and abandoned roads. ▪ Employ road and culvert maintenance practices consistent with BMPs. ▪ Replace or upgrade culvert and bridges on a priority basis to fully accommodate large storm events and to ensure unimpeded fish passage.	▪ Verd 2011 ▪ Smith and Caldwell 2001 ▪ Capoeman 1990 ▪ Lestelle and Blum 1989
Access to off-channel habitats: The availability and accessibility of off-channel habitats (ponds and wetlands) are important determinants of the performance of some salmonid populations. Man-made structures or large beaver dams can block or hinder movements to these habitats of juvenile salmonids for seasonal rearing. Re-opening, improving accessibility, or by increasing the	▪ Issue is primarily important to juvenile coho, which move into off-channel habitats as fry in late spring for summer rearing and as fingerlings in fall and early winter for overwintering. ▪ Survival and growth of coho are especially high in off-channel habitats during winter; population performance can be improved significantly when coho have access	▪ The small channels or swales connecting off-channel ponds and wetlands to the main stream can be blocked by road fills or poorly designed culverts and other crossing structures. (Ponds and wetlands can be dry during summer, making them inconspicuous when roads were built, or even to technicians doing culvert inventories.) ▪ Filling and draining of	▪ Restore, enhance, and maintain good access between main stream channels and off-channel ponds and wetlands where road structures impede passage. ▪ Enhance accessibility to off-channel habitats where accessibility is naturally impeded by beaver dams or reed canary grass. ▪ Restore and/or create new off-channel habitats as opportunities might	▪ Assess (inventory) off-channel habitats and assess connection swales/channels to main stream channels. – Use LiDAR to assess floodplain channel characteristics for first screening in larger streams; – Use on-the-ground field surveys for ground-truthing ▪ Restore natural connectivity through swales and channels in	▪ Lestelle 2009 ▪ Smith and Caldwell 2001 ▪ Cederholm and Scarlet 1991 ▪ Cederholm et al. 1988 ▪ Cederholm and Scarlet 1982 ▪ Peterson and Reid 1984

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
availability and quality of off-channel habitats can be effective ways to improve salmonid population performance. <u>Affected watersheds:</u> ▪ All but especially relevant to unconfined reaches in low gradient sections of the larger streams.	to abundant off-channel habitats.	wetlands, not uncommon in the past, has reduced the availability of these habitats. ▪ Large beaver dams—particularly old, inactive ones—can block access to juvenile coho attempting to enter off-channel habitats, or these structures can prevent emigration of smolts during spring, thereby land-locking the fish. ▪ Invasive reed canary grass can choke small, shallow connecting channels between ponds and wetlands and main stream channels.	exist. ▪ Educate the public about the role of beavers in creating off-channel habitats. ▪ Educate the public about the effects of invasive plants on the integrity and accessibility of off-channel habitats.	which passage has become impeded by fill removal, channel deepening, and correction of poorly designed crossings. ▪ Enhance off-channel habitats by deepening and/or adding structure where opportunities exist. ▪ Create new off-channel habitats by dredging and/or installation of channel flow controls to create ponds. ▪ Install and periodically maintain "beaver deceiver" devices in priority areas prone to extensive damming by beavers. ▪ Control the invasives reed canary grass and knotweeds where they have taken hold along egress channels, wetlands, and ponds. ▪ Community outreach forums and education.	
<u>Large stream floodplains and channel conditions:</u> The removal of mature forest from the upper Quinault River floodplain, together with the removal of large wood debris from the river channels, altered the natural processes that kept the river contained within relatively stable channel boundaries for hundreds of years. These changes led to the unraveling of most of the upper river between its mouth and the North Fork, creating braided channel	▪ The unstable river conditions in the upper Quinault River has destroyed most of the habitat areas used for spawning by sockeye salmon. These conditions are likely the primary reason for the significant decline of the Quinault sockeye population over the past 100 years. ▪ These conditions have also degraded habitat quality and system productivity for the other salmon species that use the upper Quinault River	▪ Land clearing along the upper Quinault River over the past 120 years removed old-growth trees, which combined with log-jams in the river channels, maintained a relatively stable system of river channels. ▪ The large old-growth trees served as hard points to facilitate channel switching between the active main channel and side-channels during flood events, and the jams served to regulate flow	▪ Increase channel stability and restore stable, vegetated islands within the river system by re-establishing large stable logjams and a coniferous riparian forest having old-growth characteristics. ▪ Where opportunities exist, relocate roads and infrastructure further back from the active river channels. ▪ Community outreach for building partnerships in the Upper Quinault Valley for effective action implementation.	▪ Construct ELJs to begin restoration of stable islands and to stabilize side channels, protect floodplain terraces, and restore more normative sediment sorting and storage processes. ▪ Improve protection of riparian lands on private property through incentives and education programs. ▪ Restore riparian forest quality with conifer underplantings. ▪ Implement actions to make needed	▪ Herrera Environmental Consultants and Quinault Department of Fisheries 2008 ▪ Fetherson 2005 ▪ USBOR 2005

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
conditions over much of this distance. The river bed, river banks, and side channels are now highly unstable. This condition has severely damaged salmon habitat. It has also threatened, and continues to threaten, property and infrastructure on the floodplain. <u>Affected watersheds:</u> ▪ Upper Quinault River	system. ▪ The effects of these altered habitat features have been losses in population performance, measured by abundance, productivity, life history diversity, and spatial structure (i.e., viable salmonid population parameters).	through overflow and active side channels. ▪ Land clearing and jam removal de-stabilized the equilibrium conditions that existed for hundreds of years, widening the channels, recruiting massive amounts of cobble and gravel stored in floodplain terraces, thereby unraveling the river system.		improvements in infrastructure in the upper Quinault valley with road setbacks, bridge improvements, and culvert replacements. ▪ Promote positive community involvement, interaction, and education through regular meetings between the Quinault Nation, the upper Quinault community, USFS, and the NPS. ▪ Periodic LiDAR flights along the Upper Quinault river channel and floodplain for assessing changes in channel networks. ▪ Implement other actions outlined in "Salmon Habitat Restoration Plan for the Upper Quinault River."	
<u>Climate change patterns and conditions in large rivers:</u> The glaciers and snowfields that have fed the mainstem Queets and Quinault rivers for hundreds of years have receded to a small fraction of what they were only 70 years ago (see Figure 4). This pattern is expected to continue at least in the near-term. Preliminary reconnaissance surveys of channel conditions suggest that large volumes of coarse sediment are being released to the upper reaches of these rivers. These conditions,	▪ Greater instability of the upper mainstem reaches will result in increased egg-fry mortality of late-summer, fall spawning species (particularly for spring/summer Chinook and bull trout). ▪ Decreased accessibility to side channel networks for spawning due to reduced late-summer flows, forcing more fish to spawn in the thwalweg of the main channel where egg-fry losses would be greatest. ▪ Effects in the upper reaches of the forks of the Quinault River could	▪ Warming pattern of climate change that has persisted over the past century. ▪ Reduced snowpack and size of the glaciers in the mountains that feed the Queets and Quinault rivers. ▪ Reduced late summer flows. ▪ Increased frequency of rain-on-snow events. ▪ Release of huge volumes of coarse sediments onto the slopes and ravines of that feed into the upper river reaches.	▪ No solution to long-term climate change is identified here – solutions to ameliorate effects or safeguard the affected populations are identified below. ▪ The "Salmon Habitat Restoration Plan for the Upper Quinault River" would have significant benefits to ameliorating effects of climate change in this part of the watershed. Similar opportunities do not exist in the Queets watershed because of the upper reaches being located in ONP.	▪ All of the actions listed above for the issue "Large stream floodplains and channel conditions" are relevant here. ▪ Actions identified for the issue "Small stream floodplains and channel conditions" are pertinent to Sams River and Matheny Creek in the Queets system. ▪ The actions listed under the issue "Restoration timescale" are relevant to both the Quinault and Queets systems. ▪ Assessment of changes to the glaciers on the south sides of Mt.	▪ Report in progress by QIN on changes in spring/summer Chinook populations in the Queets and Quinault rivers. ▪ ONP Environmental Assessment on effects of river changes on the Enchanted Valley Chalet in the Upper Quinault River. ▪ Bakke 2009. ▪ Halofsky et al. 2011.

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
combined with the potential for increasing rain-on-snow events in the Olympic Mountains, suggest greater instability of the upper river reaches. Moreover, reductions in late-summer flow likely means reduced accessibility by spring/summer Chinook (and possibly bull trout) to side channel networks preferred for spawning. <u>Affected watersheds:</u> ▪ Upper portions of the Quinault and Queets watersheds.	be expected to be translated to the lower reaches of the Upper Quinault River where the bulk of the sockeye population spawns. This would compound effects of the channel conditions that are addressed in the issue described above this one. ▪ The Queets and Quinault spring/summer Chinook populations have experienced very significant declines in abundance over the past 30 years—abundance levels may be approaching the point where depensation effects could begin (meaning even greater rates of decline and increasing risk of extirpation).		▪ In the Queets system, this might mean placing greater importance on restoring channel conditions in Matheny Creek and Sams River, both affected by intense logging in the past, where summer Chinook spawn. ▪ Greater knowledge of the population structure of the Chinook populations in the Queets and Quinault rivers would help in formulating a strategic plan for safeguarding the spring/summer components of this species. ▪ While habitat actions are being implemented and conditions are gradually improved in the rivers, interventions using conservation hatchery technology would safeguard the gene pools against demographic bottlenecks and accelerated population decline.	Olympus and Mt Anderson to the sediment loads, flow regimes, and temperature regimes of the upper Queets and Quinault rivers, considering rates of change and expectations in the near-term on impacts on relevant stocks. ▪ LiDAR flights along the Upper Quinault and Upper Queets river channels and floodplains for assessing current conditions as benchmarks for future comparisons to assess changes to side channel networks. ▪ Development of alternative strategic actions to ameliorate or offset expectations for changes in key habitats on relevant stocks. ▪ Assess genetic stock structure of the Queets and Quinault Chinook populations to learn spatial/temporal patterns of stock differentiation to guide strategic action planning for intervention actions. ▪ Assess genetic stock structure of the Quinault sockeye population to guide strategic action planning for intervention actions.	
<u>Small stream floodplains and channel conditions:</u> The channel conditions and floodplains along the	▪ The channels of smaller streams degraded through diminished loads of large wood generally	▪ Most of the old growth structure of the forest in WRIA 21, including along streams, has been	▪ Promote old-growth characteristics of riparian forests by expanding buffer widths where	▪ Add large wood debris and wood jams to streams that have diminished wood loads.	▪ Lestelle 2009 ▪ Dominguez 2006 ▪ Lestelle 2007 ▪ Saldi-Caromile et al.2004

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
smaller rivers and streams within WRIA 21 have been degraded as a result of the extensive clearcutting that occurred largely over the past half century. The timber harvesting practices resulted in significant reductions of stable, large wood debris within the channels. Where wood loads are still high, it is usually in the form of smaller material that is more mobile and composed of species conducive to rotting. These conditions have resulted in changes to stream meso-habitats (pool-riffle composition) and a reduction in habitat quality. <u>Affected watersheds:</u> ▪ All except those areas within ONP where logging has not occurred.	have reduced habitat diversity, smaller and shallower pools, greater streambed instability, and fewer stable side channels than stream channels within old-growth forests. These degraded conditions have reduced capacities for summer and winter rearing salmonids, particularly for coho, steelhead, and cutthroat. The degraded streams also will tend to have reduced egg to fry and fingerling overwinter survival as a result of more unstable conditions. ▪ The effects of these altered habitat features have been losses in population performance, measured by abundance, productivity, life history diversity, and spatial structure (i.e., viable salmonid population parameters).	removed on tribal, private and WDNR lands, as well as on significant portions of U.S. National Forest. The structure of the riparian forest, including tree species and stand age, is now markedly different than it was 50 years ago. This condition has resulted in a reduction in the recruitment of large wood material to the stream channels. ▪ Logging practices in the 1960s-1980s included the intentional removal of large wood that had recruited to the stream naturally prior to logging. Stream cleaning also occurred on streams that had been choked by logging-caused wood debris resulting from forest harvest. ▪ These practices, combined with disruption of wood not pulled out during yarding, resulted in reduced wood loads in many streams following logging. These conditions have been exacerbated by reduced natural recruitment associated with younger tree stands.	possible, or selectively logging within the riparian corridor to enhance old-growth characteristics. ▪ Enhance wood loads through direct placement where it has been diminished due to forest harvest practices.	▪ Restore old-growth characteristics of the riparian corridors. ▪ Assess wood loads in WRIA 21 streams on a priority basis to provide data needed for identifying streams with reduced loads for targeting remedial actions. ▪ Community outreach forums and education.	▪ QIN 2002 ▪ Smith and Caldwell 2001 ▪ QIN and USFS (1999, 2002) ▪ Cederholm et al. 1997a ▪ Cederholm et al. 1997b ▪ Lestelle and Blum 1989 ▪ Lestelle and Cederholm 1984
<u>Riparian conditions:</u> The widescale clearcutting of WRIA 21 forests over the past century, which was greatly accelerated in the 1960-1980s, resulted in major changes to the riparian systems along most streams. The riparian	▪ Diminished functions of the riparian corridor to the stream ecosystems of WRIA 21 occurred as the old-growth forests in most areas were cut. These changes likely resulted in less productive streams for	▪ Most of the old growth structure of the forest in WRIA 21, including along streams, has been removed on tribal, private and WDNR lands, as well as on significant portions of U.S. National Forest. The structure of the	▪ Promote old-growth characteristics of riparian forests by expanding buffer widths where possible, or use of active management practices (e.g., thinning, planting, and shrub and herb control) to accelerate	▪ Expand buffer widths on tribal and public lands where opportunities exist. ▪ Expand buffer widths on private lands through incentives and conservation easements. ▪ Restore riparian forest quality with conifer	▪ Dominguez 2006 ▪ Naiman et al. 2005 ▪ Berg et al. 2003 ▪ Smith and Caldwell 2001 ▪ Naiman et al. 1998 ▪ Lestelle and Blum 1989 ▪ Gregory et al. 1987

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
corridor affects the aquatic system through influences on stream hydrology, sediment dynamics, biochemistry and nutrient cycling, temperature, physical habitat, and food web maintenance. The riparian system today is characterized by smaller trees, less diverse and smaller riparian corridors, reduced water storage, reduced micro-climate effects on streams, and reduced stability of stream systems. Invasive knotweeds are also damaging the integrity of riparian corridors. <u>Affected watersheds:</u> ▪ All	salmonid populations of all species. ▪ Streams with riparian corridors consisting of trees regrown after timber harvest—being dominated by hardwood species—are less productive due to: reduced relative densities of macroinvertebrates and heterotrophic microorganisms, less stable substrates, reduced loads of large wood and less diverse stream habitats for fish production.	riparian forest, including tree species and stand age, is now markedly different than it was 50 years ago. ▪ Harvest of trees now occurs at a younger age than ever before, resulting in much smaller material that is recruited to streams as a result of mass wasting and blowdown where buffer strips are insufficiently wide. ▪ Invasive knotweeds are also affecting the growth and survival of native vegetation within the riparian corridor.	achievement of desired conditions within the riparian corridor. ▪ Reduce and control knotweed patches.	underplantings. ▪ Employ thinning practices within riparian forests to create desired species and age composition. ▪ Identify key land parcels for purchase and protection to safeguard and promote long-term passive restoration on important spawning and rearing streams; implement purchases as opportunities exist. ▪ Assess distribution and sizes of knotweed patches along riparian corridors (an assessment has been made in the lower Quinault drainage). ▪ Assess riparian conditions along streams where riparian conditions have not been characterized in the past 10 years. ▪ Reduce and control patches of invasive knotweeds as they become established in riparian corridors. ▪ Formulate basin-wide riparian restoration plans for each WRIA 21 watershed. ▪ Community outreach forums and education on knotweed control and on riparian restoration.	

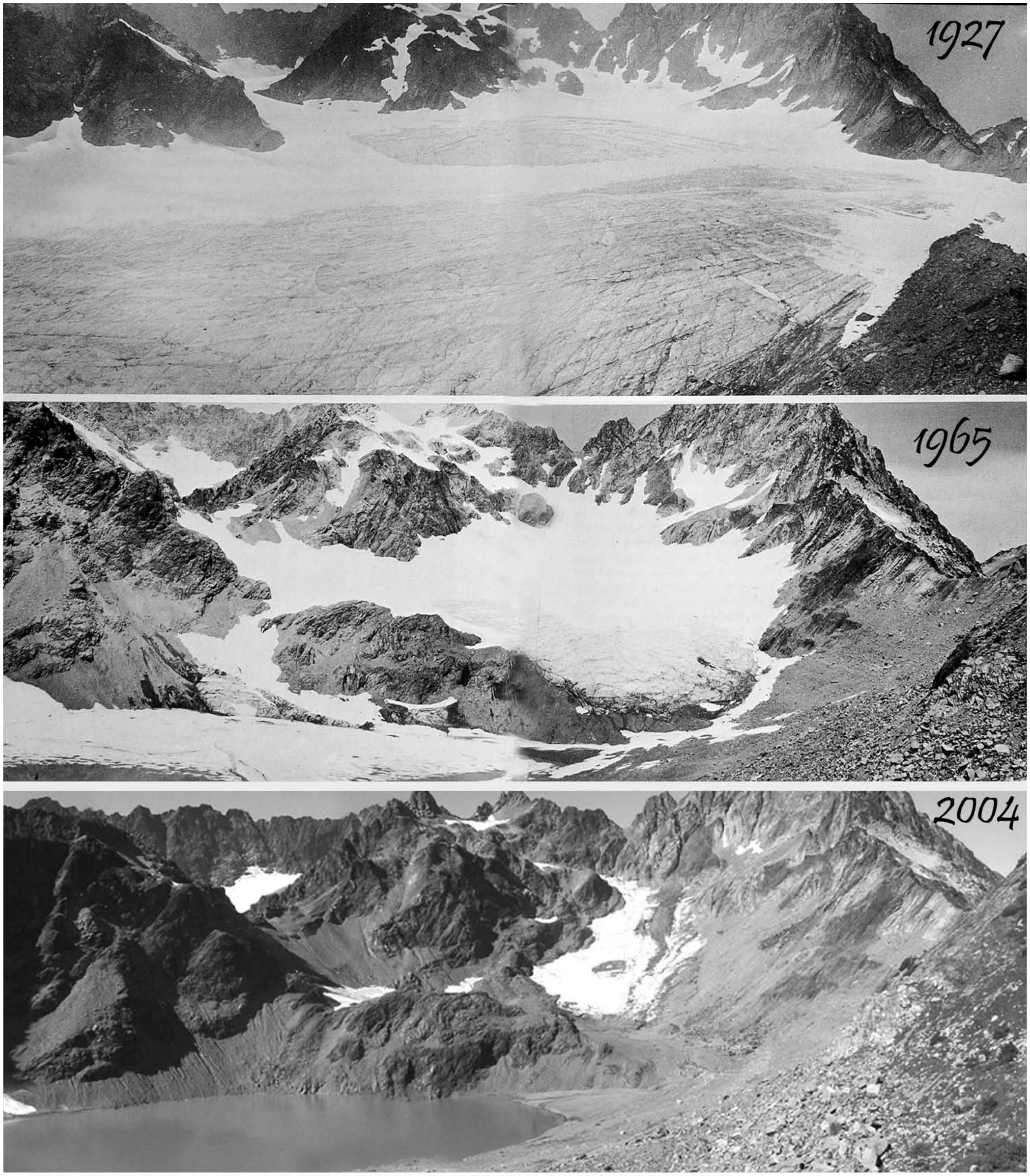
Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
Sediment loading: Most areas of the WRIA 21 stream systems had extensive road systems built through them as part of past logging practices. The exceptions are mainly those areas within the Olympic National Park. As a result, most areas have been subject to heavy logging-related sedimentation. The Clearwater subbasin is one area that was subject to significant sediment-related impacts in the past—those impacts were extensively studied in the 1970s-1980s. Similar sediment impacts are likely to have occurred in all of the other WRIA 21 basins (e.g., Lestelle and Blum 1989). Continued elevated sediment levels and related impacts likely persist to the present time in many areas where logging continues or where it was particularly severe in the past (based on Smith and Caldwell 2001 and Dominguez 2006). Affected watersheds: ▪ All except areas not previously logged within ONP.	▪ Increased sediment loading over levels typically found in old-growth forests results in higher mortalities of salmonid embryos and juveniles during egg incubation and overwintering life stages. ▪ Cederholm and Reid (1987), based on studies in the Clearwater subbasin, concluded that sediment–related habitat degradation was likely the largest contributor to Clearwater River coho mortality over natural background levels. The greater intensity of logging activity that occurred in many stream systems on the Quinault Reservation suggests that sediment impacts were likely just as significant there, if not greater, than those observed in the Clearwater subbasin (based on Lestelle and Blum 1989).	▪ Runoff from road building and vehicular traffic on gravel roads. ▪ Landslides associated with roads and clearcutting. ▪ Legacy effects of the widespread disruption of streambanks and streambeds on the coastal plain of WRIA 21 associated with yarding of the massive-sized trees that stood there, combined with the mining of downed ancient cedar trees within the streambanks and streambeds. ▪ Blowouts and slides associated with large road fills and undersized culverts. ▪ On-going erosion associated with old road drainage networks due to failed culverts and unmaintained ditches.	▪ Continue to improve forest management practices to reduce sediment yields from roads and clearcuts.	▪ Formulate Road Maintenance and Abandonment Plans (RMAP) on all forest lands and subsequent implementation for upgrading, maintaining, or decommissioning. ▪ Assess conditions of existing road systems—to include assessments of risk levels for sediment contributions to adjacent streams. ▪ Assess current intra-gravel fine sediment levels in streams of WRIA 21. These data would help determine problem areas that tend to produce high sediment loads, which could then help target remedial strategies.	▪ Dominguez 2006 ▪ QIN 2002 ▪ Smith and Caldwell 2001 ▪ QIN and USFS (1999, 2002) ▪ Lestelle and Blum 1989 ▪ Cederholm and Reid 1987 ▪ Cederholm et al. 1978 ▪ Cederholm et al. 1976 ▪ Cederholm and Lestelle 1974
Water quality conditions: Water quality, as measured by temperature, dissolved oxygen (DO), and pH, can	▪ Elevated stream temperatures can negatively affect salmonid population	▪ Large scale clearcutting affects micro-climate of stream systems and can elevate water	▪ Continue to improve forest management plans to promote more diverse stand age across the	▪ Assess current and long-term water temperature patterns in WRIA 21 streams. Data collected	▪ NRC 2009 ▪ Lestelle et al. 2005 ▪ Lawson et al. 2004 ▪ QIN 2002

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
reach levels that potentially have adverse effects on salmonids in WRIA 21 streams. (Turbidity and suspended sediment were included above under Sediment Loading.) The extensive clearcutting that occurred in the past, and still occurs, in areas of WRIA 21 can affect these water quality attributes. Generally, water temperature and DO do not reach levels to cause direct mortality, but they can result in stress and indirect effects on population performance (as reported for temperature effects on Queets coho by Lawson et al. 2004). Climate change trends may also lead to greater effects in the future. Also, past studies found that large-scale clearcuts on the westside of the Quinault Reservation exacerbated naturally low pH levels in streams in early fall—pH levels reached severely low levels (<4.0) in some streams, which could have direct effects on mortality. It is not known how the current forest harvest practices are affecting pH in these streams. It is also noted that air pollution from industrialization in China is resulting in acidic rain in the Pacific Northwest, which could exacerbate the already low pH levels in the western parts of WRIA 21.	performance by limiting growth, prompting juvenile redistribution in search of cool water refuges, or in severe cases, direct mortality. ▪ Low DO levels in late summer and early fall when flows are at seasonal lows can adversely affect population performance by limiting growth or causing direct mortality. ▪ Low pH levels in fall (concurrent with increased stream flow during storm events) can adversely affect salmon spawning success, egg and juvenile survival, and growth rates. Studies in the 1970s on the Quinault Reservation found significant correlations between the relative biomass of rearing salmonids in streams and the average fall stream pH (lower pH levels had lower salmonid biomass).	temperatures. ▪ Loss of riparian trees along streams can directly lead to elevated water temperatures. ▪ Increased water temperatures, combined with low flows and high levels of organic material, can result in diminished DO levels. This condition can be particularly severe in off-channel habitats and wetlands, and when flows are extremely low. ▪ Elevated temperatures in summer combined with the unique soil characteristics of the western WRIA 21 streams produce naturally low pH levels in streams during fall freshets. Large-scale clearcutting was found to exacerbate this condition in studies conducted in the 1970s.	landscape (i.e., avoid cutting huge contiguous land parcels at the same time). ▪ Promote diverse stand age in the managed forest. ▪ Restoration of riparian corridors having old-growth characteristics.	from long-term monitoring stations are needed to assess long-term trends that may accompany climate change patterns. (An extensive temperature effort was initiated in the Queets system by the Quinault Nation in 2011). ▪ Assess current DO patterns in WRIA 21 streams. Some level of sampling would be most useful if sampling has not occurred in recent years. ▪ Assess current and long-term stream pH patterns in WRIA 21 streams, particularly those with severely depressed pH levels seen in the 1970s (see QDNR 1976). These data would complement data collected in the 1970s. The data would help determine if air pollution from China industrialization is exacerbating over time already low pH levels in western WRIA 21 streams. ▪ All of the strategies listed under Riparian Conditions are applicable here.	▪ Smith and Caldwell 2001 ▪ QIN and USFS (1999, 2002) ▪ Zasoski et al. 1977 ▪ QDNR 1976

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
Affected watersheds: All except areas not previously logged within ONP.					
Flow regime characteristics: The rapid conversion of the old-growth forest to young, managed stands, combined with extensive road networks, in some parts of WRIA 21 have likely altered the characteristics of the natural flow regime. Attributes of the flow regime include flow magnitude, duration, timing, frequency and rate of change. The flow regime is the key driver of ecological riverine processes and associated habitat features in the stream ecosystem. Affected watersheds: All except areas not previously logged within ONP.	▪ Life history patterns and associated life stage survivals of stream dwelling salmonids are strongly affected by characteristics of the flow regime in a stream system. ▪ Peak flow intensity, runoff duration, and rate of change in flows during storm events can adversely affect egg to fry survival, emergent fry survival, and juvenile overwintering survival. ▪ Diminished low flows in late summer or early fall as a result of changes in the flow regime will generally reduce the number of coho smolts (and probably steelhead smolts) produced from tributary streams.	▪ Extensive road networks through managed forests increase rate of runoff, which can produce greater instability of streams. ▪ Replacement of old-growth forests with managed forests of much younger stands	▪ Promote diverse stand age in the managed forest to age a mixture of hydrologic maturity on the landscape. ▪ Reduce the footprint of roads in the managed areas of watersheds wherever possible.	▪ Decommission roads and restore roadbeds to pre-management conditions where possible. ▪ Drain roads to the forest floor for runoff infiltration and maintenance of water table where possible. ▪ Manage for greater diversity in stand age to the extent possible.	▪ Ziemer and Lisle 1998 ▪ Poff et al. 1997 ▪ Lestelle et al. 1993
Lake habitats conditions: Habitats used by juvenile salmonids within the littoral zone (shoreline and nearshore) of Lake Quinault can be disrupted by docks and shoreline structures. (It is noted that substantial uncertainty still exists about the effects of overhead structures in lakes.) The limiting factors analysis for WRIA 21 also lists the possible use of herbicides to control	▪ Docks and overhead structures tend to concentrate predators that prey on young salmonids. Survival of shoreline rearing salmonids (Chinook, coho, and very young sockeye fry) can be reduced by the presence of such structures. ▪ Herbicide use in aquatic systems pose risks of affecting physiological responses of adult and/or	▪ Construction and/or placement of docks and boat storage structures along the Lake Quinault shoreline. ▪ Use of herbicides in Lake Quinault to control invasive vegetation.	▪ Minimize the number of overhead structures that are located along the shoreline of Lake Quinault. (It should be noted that a lot of uncertainty still exists on the potential effects of overhead structures on juvenile salmon survival in lakes.) ▪ Control the use of herbicides in Lake Quinault.	▪ Limit or reduce the number of overhead structures along the shoreline of Lake Quinault ▪ Control the use of herbicides in Lake Quinault. ▪ Community outreach forums and education.	▪ Lestelle et al. 2010 ▪ Celedonia et al. 2008 ▪ Tabor et al. 2006 ▪ Smith and Caldwell 2001 ▪ Williams and Thom 2001

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
nearshore aquatic vegetation as a threat to juvenile salmonids in Lake Quinault. Affected watersheds: Lake Quinault.	juvenile salmon.				
Low nutrient levels in streams and Lake Quinault: Many streams and lakes of salmon ecosystems have reduced dissolved nutrient levels compared to their historic levels. This decline in nutrient levels (oligotrophication) has largely been man-caused. (Some systems are naturally relatively low nutrient levels—in these cases, they have often been reduced to even lower nutrient levels.) Oligotrophic ecosystems are nutrient-poor and are characterized by low annual rates of biotic production. Evidence shows that the aquatic systems of WRIA 21 likely have diminished nutrient levels relative to those that existed a century ago. Studies on WRIA 21 streams and Lake Quinault by QIN support this view. Affected watersheds: All.	▪ Dissolved nutrients are a critical component of salmon ecosystems. ▪ Loss of key nutrients in aquatic systems reduce the primary and secondary productivity of those systems, thereby affecting fish production—this has been demonstrated in many salmon ecosystems of the Pacific Northwest and Alaska. ▪ Reduced nutrient levels in salmon ecosystems diminish the carry capacity of stream and lake habitats. ▪ Reduced nutrient levels can also adversely affect salmon population productivity (survival measured at low population density) due to severe reductions in quality prey species.	▪ Man-related changes to the environment can reduce the amount key nutrients, including those that are marine-derived, needed by productive salmon ecosystems. ▪ Man-caused reasons for oligotrophication are drainage of wetlands, acidification, deforestation, and reductions in naturally spawning salmon. ▪ Salmon are an important conveyor of ocean nutrients to the watersheds where they were spawned. Their death after spawning enriches their natal freshwater and riparian habitats with the marine-derived nutrients. Overfishing and/or habitat degradation that reduce salmon populations can result in large reductions in marine-derived nutrients to freshwater systems.	▪ Reforestation and restoration of wetlands (these solutions are addressed through related issues above). ▪ Lake fertilization to jump-start increasing the level of nutrients in lake systems. ▪ Stream fertilization to increase the aquatic productivity of stream rearing habitats. ▪ Recovery of salmon populations to higher levels as a result of varied restoration efforts.	▪ Use fertilizer supplements in streams that are likely to be nutrient limited—three phased approach: 1. Complete assessment of ambient nutrient levels (as recommended in Armstrong and Coshow 2010) 2. Implement field trials using carcass analogs or hatchery salmon carcasses with appropriate evaluation. 3. Implement large-scale stream fertilizer supplementation as per prescriptions derived from number 2 above. ▪ Continue fertilization assessments in Lake Quinault using liquid fertilizer blends (as per QDFi 2010).	▪ Armstrong and Coshow 2010 ▪ QDFi 2010 ▪ Stockner and Bos 2006 ▪ Stockner 2003 ▪ Stockner and Ashley 2003 ▪ Stockner et al. 2003 ▪ Ward et al. 2003 ▪ Stockner 2000 ▪ Cederholm et al. 2000
Restoration timescale: The time needed to restore critical habitats for some stocks may be longer than the length of time available before the stocks drop to critical depensation levels (level where depensatory	▪ The abundances of Queets and Quinault spring/summer Chinook are in a long-term decline, which if it continues, critical depensation levels may be reached before	▪ Increased water temperatures in the lower parts of the spawning ranges of these stocks as a result of land use practices has likely contributed to the declines (Upper Quinault	▪ While habitat strategies are being implemented and conditions are gradually improved in the rivers, interventions using conservation hatchery technology would safeguard the gene pools	▪ Use technology to create artificial habitats for temporary safeguarding genetics of spring/summer Chinook stocks while other more permanent actions are pursued, and for Quinault	▪ Freymond et al. 2001

Issue	Relevance to Salmonids	Causes	Solutions	Actions	Information sources
[higher rate of mortality as population number decreases] effects increase and extinction becomes imminent). It is suspected that this is the case for Quinault and Queets spring/summer Chinook given the rate that these stocks have declined. Components of the Quinault sockeye stock may also be at risk. The status of the spring/summer stocks is of much concern—their declines appear to be due to a combination of man-caused habitat degradation and natural changes in the upper parts of the Queets and Quinault mainstem rivers (temperature and flow) related to glacier recession. Restoration of the upper Quinault valley as described in the issue "Large Stream Floodplains and Channel Conditions" will greatly help in the recovery of this stock. A partial assessment of factors affecting the Queets stock is underway. A strategy to safeguard the genetics of these stocks may be needed until habitat solutions can be adequately addressed. <u>Affected watersheds:</u> Stocks in the upper parts of the Queets and Quinault watersheds.	habitat remedies can be adequately addressed. ▪ Loss of genetic structure and diversity is expected to occur once the effective breeding population sizes drop to certain levels. ▪ Protection of the gene pools of these stocks using artificial means may be needed to avoid extinction and enable recovery to proceed as habitat restoration occurs.	downstream of North Fork, Queets River downstream of Sams River, Sams River, Matheny Creek, Clearwater River). ▪ Increased egg-fry mortality resulting from greater instability of spawning reaches due to a combination of land uses and natural events. ▪ The time required to improve stock productivity related to these habitat changes may require several decades.	against demographic bottlenecks and accelerated population decline.	sockeye as the need might become evident: 1. Feasibility assessment for developing captive brood stocks. 2. Development of small conservation hatchery facility to supply secure habitat for safeguarding genetic resources of the stocks. 3. Implement actions to develop captive brood stocks to provide for supplementation for a prescribed number of brood cycles.	Sharma et al. 2006



Anderson Glacier on the southern slope of Mount Anderson. The top two are from the book, Guide to the Geology of Olympic National Park by Rowland W. Tabor, UW Press, 1975. They were taken by W.M. Cady. I took the bottom one in October 2004.

Figure 4. Photographs of Anderson Glacier, the source of the east fork of the Quinault River. Pictures assembled by Larry Workman (Quinault Indian Nation). Bottom picture taken by L. Workman. The glacier is located on the south face of Mt. Anderson. Similar recession has occurred to glaciers on the south face of Mt. Olympus, which feed the Queets River.

Figure 5. Action applicability for addressing habitat-related performance of WRIA 21 stocks (multi page).

Issue	Action	Kal_Coho	Kal_WSth	Kal_Cutt	Qts_SChin	Clear_SChin	Qts_FChin	Clear_FChin	Qts_Coho	Clear_Coho	Sal_Coho	Qts_Chum	Qts_SSth	Clear_SSth	Qts_WSth
Access to in-stream habitats	Assess stream crossing structures for fish passage	3	2	3	0	0	1	1	2	2	2	1	1	1	2
	Remove stream crossing structures on abandoned roads	3	3	3	0	0	1	1	2	2	2	1	1	1	2
	Employ road/culvert maintenance BMPs	3	3	3	1	2	3	3	3	3	3	3	1	2	3
	Replace/upgrade culverts and bridges on priority basis	3	2	3	1	0	1	1	2	2	2	1	1	1	2
Access to off-channel habitats	Assess connect. of off-channel habs (some LiDAR)	2	0	1	0	0	0	0	3	3	3	0	0	0	0
	Restore off-channel habitat natural connectivity	2	0	1	0	0	0	0	3	3	3	0	0	0	0
	Enhance off-channel habitats features	2	0	1	0	0	0	0	3	3	3	0	0	0	0
	Create new off-channel habitats	2	0	1	0	0	0	0	3	3	3	0	0	0	0
	Install/maintain “beaver deceiver” devices	2	0	1	0	0	0	0	3	3	3	0	0	0	0
	Control invasives (reed canary grass, knotweeds)	3	0	3	0	0	0	0	3	3	3	0	0	0	0
	Community outreach forums and education	1	0	1	0	0	0	0	1	3	1	0	0	0	0
Large stream floodplains and channel conditions (Upper Quinault)	Construct ELJs to restore stable islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Protect riparian lands on private property with incentives	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Restore coniferous riparian forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Infrastructure improvements in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Periodic LiDAR flights to assess changes in channels	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Promote positive interactions in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other actions in Upper Quinault Habitat Restoration Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Climate change patterns and conditions in large rivers (Upper Queets/Quinault)	Assess changes to glaciers on Mts. Anderson/Olympus	0	0	0	3	0	1	0	1	0	0	0	1	0	0
	Assess channels in upper reaches (LiDAR)	0	0	0	3	0	1	0	1	0	0	0	1	0	0
	Develop alternative action plans to offset effects	0	0	0	3	0	0	0	0	0	0	0	1	0	0
	Assess genetic stock structure of spring/summer chinook	0	0	0	3	3	3	3	0	0	0	0	0	0	0
	Assess genetic stock structure of Quinault sockeye	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small stream floodplains and channel conditions	Add large wood debris to streams	2	2	1	2	1	2	2	3	3	3	2	2	2	3
	Restore old-growth characteristics of riparian corridors	3	3	3	2	2	2	3	3	3	3	2	2	2	3
	Assess wood loads in streams on a priority basis	3	3	3	2	1	2	3	3	3	3	2	2	2	3
	Community outreach forums and education	1	1	1	1	1	1	2	1	2	1	0	1	1	1
Riparian conditions	Expand buffer widths on tribal and public lands	3	3	3	2	2	3	3	3	3	3	1	2	2	3
	Expand buffer widths on private lands with incentives	3	3	3	0	1	3	3	0	3	0	0	0	1	2
	Restore riparian forest quality with conifer underplantings	3	3	3	2	2	3	3	3	3	3	1	2	2	3
	Employ thinning practices within riparian forests	3	3	3	2	2	3	3	3	3	3	1	2	2	3
	Assess key land parcels for purchase and protection	1	1	1	2	2	2	2	1	3	2	0	2	2	2
	Formulate riparian restoration plans for each watershed	3	3	3	2	2	3	3	3	3	3	1	2	2	3
	Assess and control invasive knotweeds	3	3	3	2	2	3	3	3	3	3	1	2	2	3
	Community outreach forums and education	1	1	1	1	2	1	2	1	2	1	0	1	2	1
Sediment loading	Implement Road Maintenance and Abandonment Plans	3	3	3	2	2	2	3	3	3	3	2	2	2	3
	Assess conditions of existing road systems	3	3	3	3	3	3	3	3	3	3	2	3	3	3
	Assess current intra-gravel fine sediment levels in streams	3	3	3	2	2	2	2	3	3	3	2	0	2	3
Water quality conditions	Assess water temperature patterns/levels in streams	3	3	3	3	3	3	3	3	3	3	0	3	3	3
	AssessDO pattern/levels in streams and off-channels	1	0	1	0	0	0	0	1	1	1	0	0	0	0
	Assess stream pH pattern/levels	1	1	1	0	0	0	0	1	1	1	0	0	0	0
Flow regime characteristics	Decommission roads and restore to prior conditions	2	2	2	1	2	2	2	2	2	2	1	1	1	2
	Drain roads to the forest floor for runoff infiltration	2	2	2	1	2	2	2	2	2	2	1	1	1	2
	Manage for greater diversity in forest stand age	2	2	2	1	2	2	2	2	2	2	1	1	1	2
Lake habitats conditions	Limit/reduce overhead structures in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Prevent use of herbicides in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low nutrient levels in streams and Lake Quinault	Use fertilizer supplements in nutrient poor streams	2	2	2	1	1	1	1	2	2	2	1	1	1	2
	Continue fertilization assessments in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Restoration timescale	Employ captive brood strategy while habitat restored	0	0	0	3	3	0	0	0	0	0	0	0	0	0

KEY NA 0 Low 1 Med 2 High 3

Figure 5. Action applicability – continued.

Issue	Action	Clear_WSth	Qts_Cutt	Qts_Bull	Wha_Cutt	Raft_Coho	Raft_WSth	Raft_Cutt	Camp_Coho	Camp_Cutt	Duck_Cutt	UQuin_SChi	LQuin_SChin	UQuin_FChi	LQuin_FChin
Access to in-stream habitats	Assess stream crossing structures for fish passage	2	2	0	3	3	3	3	3	3	3	0	0	1	2
	Remove stream crossing structures on abandoned roads	2	2	0	3	3	3	3	3	3	3	0	0	1	2
	Employ road/culvert maintenance BMPs	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Replace/upgrade culverts and bridges on priority basis	2	2	0	3	3	3	3	3	3	3	2	0	2	2
Access to off-channel habitats	Assess connect. of off-channel habs (some LiDAR)	0	1	0	0	2	0	1	0	0	0	0	0	0	0
	Restore off-channel habitat natural connectivity	0	1	0	0	2	0	1	0	0	0	0	0	0	0
	Enhance off-channel habitats features	0	1	0	0	2	0	1	0	0	0	0	0	0	0
	Create new off-channel habitats	0	1	0	0	2	0	1	0	0	0	0	0	0	0
	Install/maintain "beaver deceiver" devices	0	1	0	0	1	0	1	0	0	0	0	0	0	0
	Control invasives (reed canary grass, knotweeds)	0	3	0	0	3	0	3	3	3	3	0	0	0	0
	Community outreach forums and education	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large stream floodplains and channel conditions (Upper Quinault)	Construct ELJs to restore stable islands	0	0	0	0	0	0	0	0	0	0	3	0	3	0
	Protect riparian lands on private property with incentives	0	0	0	0	0	0	0	0	0	0	3	0	3	0
	Restore coniferous riparian forest	0	0	0	0	0	0	0	0	0	0	3	0	3	0
	Infrastructure improvements in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	3	0	3	0
	Periodic LiDAR flights to assess changes in channels	0	0	0	0	0	0	0	0	0	0	3	0	2	0
	Promote positive interactions in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	3	0	3	0
	Other actions in Upper Quinault Habitat Restoration Plan	0	0	0	0	0	0	0	0	0	0	2	0	2	0
Climate change patterns and conditions in large rivers (Upper Queets/Quinault)	Assess changes to glaciers on Mts. Anderson/Olympus	0	0	3	0	0	0	0	0	0	0	3	0	2	0
	Assess channels in upper reaches (LiDAR)	0	0	3	0	0	0	0	0	0	0	3	0	2	0
	Develop alternative action plans to offset effects	0	0	1	0	0	0	0	0	0	0	3	0	0	0
	Assess genetic stock structure of spring/summer chinook	0	0	0	0	0	0	0	0	0	0	3	3	3	3
	Assess genetic stock structure of Quinault sockeye	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small stream floodplains and channel conditions	Add large wood debris to streams	3	2	0	0	1	1	1	1	0	0	0	2	0	2
	Restore old-growth characteristics of riparian corridors	3	3	2	3	3	3	3	3	3	3	3	3	1	3
	Assess wood loads in streams on a priority basis	3	2	1	1	2	2	2	2	2	2	1	2	1	2
	Community outreach forums and education	2	1	0	0	0	0	0	0	0	0	1	0	1	2
Riparian conditions	Expand buffer widths on tribal and public lands	3	2	1	1	2	2	2	2	2	2	2	3	2	3
	Expand buffer widths on private lands with incentives	2	2	1	1	0	0	0	0	0	0	3	0	3	0
	Restore riparian forest quality with conifer underplantings	3	3	1	1	3	3	3	3	3	3	3	3	3	3
	Employ thinning practices within riparian forests	3	3	1	1	3	3	3	2	2	2	2	2	2	2
	Assess key land parcels for purchase and protection	2	1	1	1	0	0	0	0	0	0	3	0	3	0
	Formulate riparian restoration plans for each watershed	3	3	1	1	3	3	3	3	3	3	3	3	3	3
	Assess and control invasive knotweeds	3	3	1	1	3	3	3	3	3	3	3	3	3	3
	Community outreach forums and education	1	1	0	0	0	0	0	0	0	0	3	2	3	2
Sediment loading	Implement Road Maintenance and Abandonment Plans	3	3	1	3	3	3	3	3	3	3	1	3	1	3
	Assess conditions of existing road systems	3	3	1	3	3	3	3	3	3	3	3	3	3	3
	Assess current intra-gravel fine sediment levels in streams	3	3	0	0	1	1	1	0	0	0	3	3	3	3
Water quality conditions	Assess water temperature patterns/levels in streams	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AssessDO pattern/levels in streams and off-channels	0	0	0	1	1	1	1	1	1	1	0	0	0	0
	Assess stream pH pattern/levels	0	0	0	1	1	1	1	1	1	1	0	0	0	0
Flow regime characteristics	Decommission roads and restore to prior conditions	2	2	0	1	2	2	1	2	1	1	1	2	1	2
	Drain roads to the forest floor for runoff infiltration	2	2	0	1	2	2	2	2	1	1	1	1	0	2
	Manage for greater diversity in forest stand age	2	2	0	1	2	2	2	2	1	1	2	2	2	2
Lake habitats conditions	Limit/reduce overhead structures in Lake Quinault	0	0	0	0	0	0	0	0	0	0	2	0	2	0
	Prevent use of herbicides in Lake Quinault	0	0	0	0	0	0	0	0	0	0	2	0	2	0
Low nutrient levels in streams and Lake Quinault	Use fertilizer supplements in nutrient poor streams	2	1	0	0	0	0	0	0	0	0	1	1	1	1
	Continue fertilization assessments in Lake Quinault	0	0	0	0	0	0	0	0	0	0	3	0	3	0
Restoration timescale	Employ captive brood strategy while habitat restored	0	0	0	0	0	0	0	0	0	0	3	0	0	0

KEY NA 0 Low 1 Med 2 High 3

Figure 5. Action applicability – continued.

Issue	Action	Cook_FChin	UQuin_Chu	LQuin_Chu	UQuin_Coh	LQuin_Coho	Cook_Coho	Quin_Sock	Quin_SSth	UQuin_WSt	LQuin_WSth	Quin_Cutt	Quin_Bull	Wrk_Coho	Wrk_WSth
Access to in-stream habitats	Assess stream crossing structures for fish passage	2	0	3	1	3	3	0	1	1	3	3	1	3	3
	Remove stream crossing structures on abandoned roads	2	0	3	2	3	3	0	1	1	3	3	1	3	3
	Employ road/culvert maintenance BMPs	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Replace/upgrade culverts and bridges on priority basis	2	1	3	2	3	3	3	1	1	3	3	1	3	3
Access to off-channel habitats	Assess connect. of off-channel habs (some LiDAR)	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Restore off-channel habitat natural connectivity	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Enhance off-channel habitats features	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Create new off-channel habitats	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Install/maintain "beaver deceiver" devices	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Control invasives (reed canary grass, knotweeds)	0	0	0	3	3	3	0	0	0	0	1	0	0	0
	Community outreach forums and education	0	0	0	2	2	2	0	0	0	0	1	0	0	0
Large stream floodplains and channel conditions (Upper Quinault)	Construct ELJs to restore stable islands	0	3	0	3	0	0	3	3	3	0	3	3	0	0
	Protect riparian lands on private property with incentives	0	3	0	3	0	0	3	3	3	0	3	3	0	0
	Restore coniferous riparian forest	0	3	0	3	0	0	3	3	3	0	3	3	0	0
	Infrastructure improvements in upper Quinault valley	0	3	0	3	0	0	3	3	3	0	3	3	0	0
	Periodic LiDAR flights to assess changes in channels	0	2	0	3	0	0	3	2	2	0	2	2	0	0
	Promote positive interactions in upper Quinault valley	0	3	0	3	0	0	3	3	3	0	3	3	0	0
	Other actions in Upper Quinault Habitat Restoration Plan	0	3	0	3	0	0	3	3	3	0	3	3	0	0
Climate change patterns and conditions in large rivers (Upper Queets/Quinault)	Assess changes to glaciers on Mts. Anderson/Olympus	0	1	0	1	0	0	3	1	0	0	0	3	0	0
	Assess channels in upper reaches (LiDAR)	0	1	0	1	0	0	3	1	0	0	0	3	0	0
	Develop alternative action plans to offset effects	0	0	0	0	0	0	0	1	0	0	0	1	0	0
	Assess genetic stock structure of spring/summer chinook	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Assess genetic stock structure of Quinault sockeye	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Small stream floodplains and channel conditions	Add large wood debris to streams	1	3	2	3	2	1	3	3	3	2	2	3	1	1
	Restore old-growth characteristics of riparian corridors	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Assess wood loads in streams on a priority basis	2	2	2	3	2	2	3	3	3	2	2	3	2	2
	Community outreach forums and education	2	3	2	3	2	2	3	3	3	2	2	3	0	0
Riparian conditions	Expand buffer widths on tribal and public lands	3	2	3	2	3	3	2	2	2	3	3	2	2	2
	Expand buffer widths on private lands with incentives	0	3	0	3	0	0	3	3	3	0	0	3	0	0
	Restore riparian forest quality with conifer underplantings	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Employ thinning practices within riparian forests	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Assess key land parcels for purchase and protection	0	3	0	3	0	0	3	3	3	0	0	3	0	0
	Formulate riparian restoration plans for each watershed	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Assess and control invasive knotweeds	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Community outreach forums and education	2	3	2	3	2	2	3	3	3	2	2	3	0	0
Sediment loading	Implement Road Maintenance and Abandonment Plans	3	1	3	1	3	3	1	1	1	3	3	1	3	3
	Assess conditions of existing road systems	3	3	3	3	3	3	3	3	3	3	3	2	3	3
	Assess current intra-gravel fine sediment levels in streams	3	3	3	3	3	3	3	3	3	3	1	0	0	0
Water quality conditions	Assess water temperature patterns/levels in streams	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AssessDO pattern/levels in streams and off-channels	0	0	0	0	1	1	0	0	0	0	0	0	0	0
	Assess stream pH pattern/levels	0	0	0	0	1	1	0	0	1	0	0	0	1	1
Flow regime characteristics	Decommission roads and restore to prior conditions	2	1	2	1	2	2	1	1	1	2	2	1	2	2
	Drain roads to the forest floor for runoff infiltration	2	1	2	1	2	2	1	1	1	2	2	1	2	2
	Manage for greater diversity in forest stand age	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Lake habitats conditions	Limit/reduce overhead structures in Lake Quinault	0	1	0	2	0	0	2	1	1	0	2	2	0	0
	Prevent use of herbicides in Lake Quinault	0	2	0	2	0	0	2	2	2	0	2	2	0	0
Low nutrient levels in streams and Lake Quinault	Use fertilizer supplements in nutrient poor streams	0	0	1	1	1	0	0	1	1	1	1	1	0	0
	Continue fertilization assessments in Lake Quinault	0	3	0	3	0	0	3	3	3	0	3	3	0	0
Restoration timescale	Employ captive brood strategy while habitat restored	0	0	0	0	0	0	2	0	0	0	0	0	0	0

KEY NA 0 Low 1 Med 2 High 3

Figure 5. Action applicability – continued.

Issue	Action	Wrk_Cutt	Moc_Coho	Moc_WSth	Moc_Cutt	Moc_Bull	Joe_Coho	Joe_WSth	Joe_Cutt	Cop_Coho	Cop_WSth	Cop_Cutt	Cop_Bull	Con_Coho	Con_Cutt
Access to in-stream habitats	Assess stream crossing structures for fish passage	3	3	3	3	0	3	3	3	3	3	3	0	3	3
	Remove stream crossing structures on abandoned roads	3	3	3	3	0	3	3	3	3	3	3	0	3	3
	Employ road/culvert maintenance BMPs	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Replace/upgrade culverts and bridges on priority basis	3	3	3	3	0	3	3	3	3	3	3	0	3	3
Access to off-channel habitats	Assess connect. of off-channel habs (some LiDAR)	0	2	0	1	0	2	0	1	2	0	1	0	0	0
	Restore off-channel habitat natural connectivity	0	2	0	1	0	2	0	1	2	0	1	0	0	0
	Enhance off-channel habitats features	0	2	0	1	0	2	0	1	2	0	1	0	0	0
	Create new off-channel habitats	0	2	0	1	0	2	0	1	2	0	1	0	0	0
	Install/maintain "beaver deceiver" devices	0	1	0	1	0	1	0	1	1	0	1	0	0	0
	Control invasives (reed canary grass, knotweeds)	0	3	0	3	0	3	0	3	3	0	3	0	3	3
	Community outreach forums and education	0	1	0	1	0	1	0	1	1	0	1	0	1	1
Large stream floodplains and channel conditions (Upper Quinault)	Construct ELJs to restore stable islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Protect riparian lands on private property with incentives	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Restore coniferous riparian forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Infrastructure improvements in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Periodic LiDAR flights to assess changes in channels	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Promote positive interactions in upper Quinault valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other actions in Upper Quinault Habitat Restoration Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Climate change patterns and conditions in large rivers (Upper Queets/Quinault)	Assess changes to glaciers on Mts. Anderson/Olympus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Assess channels in upper reaches (LiDAR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Develop alternative action plans to offset effects	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Assess genetic stock structure of spring/summer chinook	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Assess genetic stock structure of Quinault sockeye	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small stream floodplains and channel conditions	Add large wood debris to streams	0	1	1	0	0	1	1	0	1	1	0	0	0	0
	Restore old-growth characteristics of riparian corridors	3	3	3	3	3	1	1	1	1	1	1	1	1	1
	Assess wood loads in streams on a priority basis	2	2	2	2	0	2	2	2	2	2	2	0	0	0
	Community outreach forums and education	1	1	1	1		0	0	0	0					
Riparian conditions	Expand buffer widths on tribal and public lands	2	2	2	2	2	0	0	0	0	0	0	0	0	0
	Expand buffer widths on private lands with incentives	0	1	1	1	0	1	1	1	1	1	1	0	1	1
	Restore riparian forest quality with conifer underplantings	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Employ thinning practices within riparian forests	2	2	2	2	2	1	1	1	1	1	1	1	1	1
	Assess key land parcels for purchase and protection	0	0	0	0	0	1	1	1	1	1	1	0	0	0
	Formulate riparian restoration plans for each watershed	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Assess and control invasive knotweeds	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Community outreach forums and education	0	0	0	0	0	2	2	2	2	2	2	2	2	2
Sediment loading	Implement Road Maintenance and Abandonment Plans	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Assess conditions of existing road systems	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Assess current intra-gravel fine sediment levels in streams	0	1	1	0	0	0	0	0	1	1	0	0	0	0
Water quality conditions	Assess water temperature patterns/levels in streams	3	3	3	3	3	3	3	3	3	3	3	3	1	1
	AssessDO pattern/levels in streams and off-channels	0	1	1	1	0	1	1	1	1	1	1	0	0	0
	Assess stream pH pattern/levels	1	1	1	1	0	1	1	1	1	1	1	0	1	1
Flow regime characteristics	Decommission roads and restore to prior conditions	1	2	2	1	0	2	2	1	2	2	1	0	1	1
	Drain roads to the forest floor for runoff infiltration	1	2	2	1	0	2	2	1	2	2	1	0	1	1
	Manage for greater diversity in forest stand age	1	2	2	1	0	2	2	1	2	2	1	0	1	1
Lake habitats conditions	Limit/reduce overhead structures in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Prevent use of herbicides in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low nutrient levels in streams and Lake Quinault	Use fertilizer supplements in nutrient poor streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Continue fertilization assessments in Lake Quinault	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Restoration timescale	Employ captive brood strategy while habitat restored	0	0	0	0	0	0	0	0	0	0	0	0	0	0

KEY NA 0 Low 1 Med 2 High 3

Table 8. Definitions for ratings applied to expectations for actions relative to the amount of time needed to realize full benefits, effectiveness at addressing the related issue, and the geographic scale needed to address the issue. Ratings assigned to each action are given in Table 9.

Level	Description
Time needed for maturation of effects	
Level	Description
1	Very rapid effect (<5 years)
2	Intermediate time to full effect (5-25 years)
3	Long period to full effect (>25 years)
Relative effectiveness of action	
Level	Description
1	Modest effectiveness
2	Intermediate effectiveness
3	Highly effective
Geographic coverage (scale) needed	
Level	Description
1	Modest scale treatment needed for full effect
2	Intermediate scale treatment needed for full effect
3	Large scale treatment needed for full effect

Table 9. Expectations for each action relative to the amount of time needed to realize full benefits, relative effectiveness at addressing the related issue, and the relative geographic scale needed to address the issue. See Table 8 for numeric rating definitions.

Issue	Action	Time needed	Effective-ness	Scale needed
Access to in-stream habitats	Assess stream crossing structures for fish passage	1	3	3
	Remove stream crossing structures on abandoned roads	1	3	1
	Employ road/culvert maintenance BMPs	1	2	3
	Replace/upgrade culverts and bridges on priority basis	1	3	1
Access to off-channel habitats	Assess connect. of off-channel habs (some LiDAR)	1	3	2
	Restore off-channel habitat natural connectivity	1	3	2
	Enhance off-channel habitats features	1	3	2
	Create new off-channel habitats	1	3	2
	Install/maintain "beaver deceiver" devices	1	2	2
	Control invasives (reed canary grass, knotweeds)	3	2	2
	Community outreach forums and education	2	2	1
Large stream floodplains and channel conditions (Upper Quinault)	Construct ELJs to restore stable islands	2	3	3
	Protect riparian lands on private property with incentives	3	2	2
	Restore coniferous riparian forest	3	2	2
	Infrastructure improvements in upper Quinault valley	1	2	2
	Periodic LiDAR flights to assess changes in channels	2	1	2
	Promote positive interactions in upper Quinault valley	2	2	1
	Other actions in Upper Quinault Habitat Restoration Plan	3	2	2
Climate change patterns and conditions in large rivers (Upper Queets/Quinault)	Assess changes to glaciers on Mts. Anderson/Olympus	1	1	2
	Assess channels in upper reaches (LiDAR)	2	1	2
	Develop alternative action plans to offset effects	1	1	2
	Assess genetic stock structure of spring/summer chinook	1	1	2
	Assess genetic stock structure of Quinault sockeye	1	1	2
Small stream floodplains and channel conditions	Add large wood debris to streams	1	3	3
	Restore old-growth characteristics of riparian corridors	3	3	3
	Assess wood loads in streams on a priority basis	1	3	3
	Community outreach forums and education	2	2	1
Riparian conditions	Expand buffer widths on tribal and public lands	3	2	3
	Expand buffer widths on private lands with incentives	3	2	3
	Restore riparian forest quality with conifer underplantings	3	2	3
	Employ thinning practices within riparian forests	2	2	3
	Assess key land parcels for purchase and protection	1	2	2
	Formulate riparian restoration plans for each watershed	1	2	2
	Assess and control invasive knotweeds	3	2	2
	Community outreach forums and education	2	2	1
Sediment loading	Implement Road Maintenance and Abandonment Plans	2	2	2
	Assess conditions of existing road systems	1	3	2
	Assess current intra-gravel fine sediment levels in streams	1	3	2
Water quality conditions	Assess water temperature patterns/levels in streams	1	3	2
	AssessDO pattern/levels in streams and off-channels	1	3	2
	Assess stream pH pattern/levels	1	3	2
Flow regime characteristics	Decommission roads and restore to prior conditions	2	2	2
	Drain roads to the forest floor for runoff infiltration	1	2	2
	Manage for greater diversity in forest stand age	3	2	2
Lake habitats conditions	Limit/reduce overhead structures in Lake Quinault	1	2	1
	Prevent use of herbicides in Lake Quinault	1	2	1
Low nutrient levels in streams and Lake Quinault	Use fertilizer supplements in nutrient poor streams	1	2	2
	Continue fertilization assessments in Lake Quinault	1	2	1
Restoration timescale	Employ captive brood strategy while habitat restored	2	3	1

6.0 Applying the Strategy for Project Development

The strategy presented in this document provides a simple roadmap for moving forward with salmon habitat recovery planning in WRIA 21 watersheds. It describes an updated, refined means for developing restoration, protection, and assessment projects.

Guidance is provided for identifying priority stocks, from which geographic areas can be identified, and priority actions. It bears noting, however, that opportunities or special issues may present themselves for project development not captured in the guidance given here. For example, a landowner may volunteer his land for certain types of projects that presents an opportunity for restoration that might not fit neatly into the prioritization scheme given here. In such case, special consideration would be given for project development to use that opportunity. In most cases, project planning should proceed by applying the priority guidance presented herein.

The following steps and questions should be considered in developing projects:

1. Focus first on the highest priority stocks, which can be considered in the priority tiers identified in Figure 2. If all things are equal between potential projects, the higher priority stocks should be targeted.
    a. Tier 1 stocks
    b. Tier 2 stocks
    c. Tier 3 stocks
    d. Tier 4 stocks

2. What limiting factors are most likely to be of concern to the priority stocks? Useful information is provided in Smith and Caldwell (2001) to help address this. Table 7 also provides information that can be used to help draw diagnostic conclusions in this regard. This step is important in that it forces the planner to identify the logic being applied in why one or more actions are being selected. The diagnostic conclusion is essentially a hypothesis about the factors affecting the stocks of interest.

3. Identify the most likely geographic areas associated with stocks in focus and the target limiting factors. Consider giving greater attention to areas that affect the most priority stocks. Consideration here needs to be given to the source geographic areas creating the limiting factors of conern. For example, sediment that is affecting a stock in a particular set of stream reaches is produced where? Watershed processes need to be consider in this step.

4. What actions are most applicable for addressing the issue of concern? All of the actions are rated in Figure 5 for likely applicability to the stocks in WRIA 21. Applicability is rated as likely being High, Moderate, or Low, or not applicable. Give greater attention in planning to actions with the highest rating for applicability.

5. Consider the three aspects of actions that relate to time lag for effectiveness, action effectiveness, and the scale of the project that might be needed (Table 9).
    a. How long will the action likely take to mature and produce benefits to the stock?
    b. How effective is the action likely to be in affecting the limiting factor(s) of concern?
    c. How large does the project likely need to be to realize the desired effect?

6. Other considerations:
    a. Consider opportunities for leveraging actions in areas where opportunities may exist with landowners or other natural resource actions that are occurring.
    b. Consider the general level of community support or concern that might exist with the action. A project might provide an opportunity for involving the community in such a way as to serve as vehicle for promoting awareness about the issue.
    c. Finally, project cost and the potential for being achieving the level of funding needed are critical.

Some concluding remarks are in order. Salmon restoration efforts are underway throughout the Pacific Northwest and Northern California. In many regions, the issues are far more complex and difficult than those that exist in WRIA 21. Within the Puget Sound regions, for example, the rivers there for the most part are much more degraded than conditions in WRIA 21. Urbanization, dams and water diversions, river channelization and diking, and agriculture, in addition to forest management are widespread (Montgomery et al. 2003). Still, in those rivers, it is hoped that salmon recovery can be achieved through restoration efforts—but the outlook is far less certain than it is in WRIA 21.

The issues faced in WRIA 21, while difficult due to extensive changes that have been made to the landscapes, are far more tractable than in most, if not all, other areas of Washington State and the Pacific Northwest. Large portions of the WRIA remain in pristine wilderness and habitat conditions in those areas are among the best anywhere in the Pacific Northwest. The portions of the watersheds downstream of wilderness areas are primarily managed for forest practices, presenting much simpler issues than in regions where more diverse land and water uses exist. The relatively small areas that encompass the human communities within WRIA 21, and their associated land uses, do not pose the complexity and scale of issues seen elsewhere.

Given the opportunities that exist for salmon habitat restoration in WRIA 21, we ask: If not here, then where? We believe that we have a good, basic understanding of the ecological processes about the aquatic systems of WRIA 21, and we know enough to be acting effectively now.

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