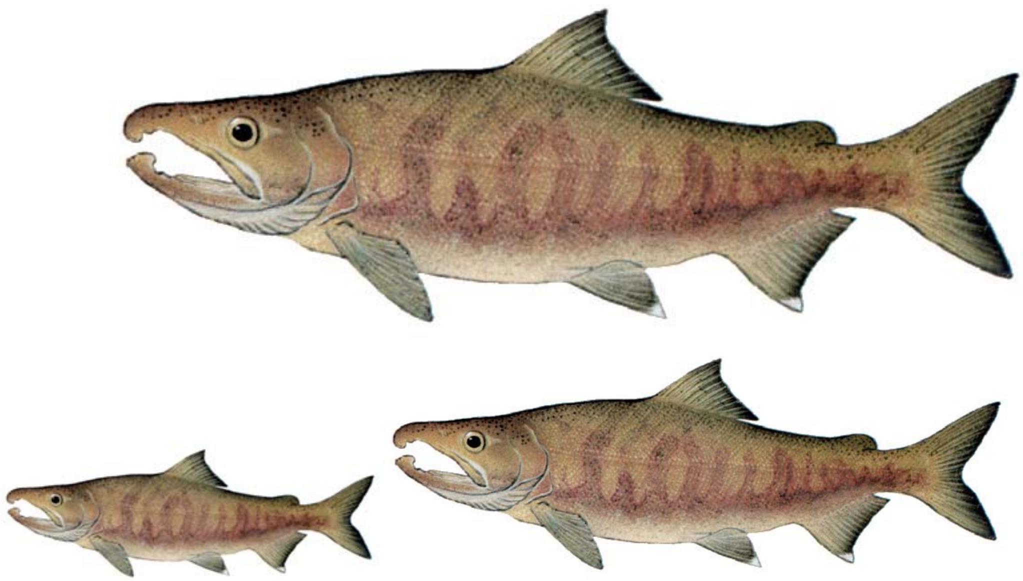
PACIFIC COUNTY (WRIA 24) STRATEGIC PLAN FOR SALMON RECOVERY



CHUM SALMON (Oncorhynchus keta)

June 29, 2001

Prepared for:
Pacific County
P.O. Box 68
South Bend, WA 98586

Prepared by :
Applied Environmental Services, Inc
1550 Woodridge Dr. SE
Port Orchard, WA 98366

TABLE OF CONTENTS   Page i

1.0 Executive Summary

1.1 The Pacific County (WRIA 24) Strategic Plan for Salmon Recovery

The overall goal of the Pacific County (WRIA 24) Strategic Salmon Recovery Plan (Strategic Plan) is to re-establish the connection between fish and their habitat through the identification of human actions and their effects on salmon survival. This Pacific County (WRIA 24) Strategic Salmon Recovery Plan offers a scientific framework enabling the selection of projects that most effectively restore and preserve the natural habitat features and landscape processes critical to sustained salmon survival. The Plan as a whole provides scientific support for priority projects through recently completed watershed assessments and various habitat feasibility studies. The Plan provides a lower priority to potential projects that do not clearly facilitate wild salmon restoration and protection and those that do not have a high probability of success in benefiting salmonid populations. The Plan brings to light projects that will significantly increase the value of fish habitat by restoring the processes that have historically sustained ecosystem function.

With the use of the Strategic Plan and other related information, Pacific County will continue to promote projects addressing the causes, rather than the symptoms of watershed degradation. This strategic plan was developed to promote efficient and effective use of public and private money for salmon restoration projects with a high likelihood of success. One goal of this strategy is to assist and encourage the voluntary restoration and protection of natural landscape processes that formed and sustained the habitats to which salmon stocks are adapted. This strategy addressed habitat issues and is only a part of the effort necessary to restore salmon populations at the river basin scale.

This strategy:

- Presents, in one summary document, a brief description of each watershed, followed by a discussion of limiting factors associated with that watershed and methods for evaluating those limiting factors.
- Provides criteria for evaluating the likelihood of success of salmon habitat restoration and protection projects.
- Allow the WBWRCC to identify and endorse projects based on a common set of principles.
- Focuses efforts to areas with the greatest potential for salmon restoration and protection.
- Promotes projects that are most cost-effective first based on an analysis of costs and benefits to the ecosystem.
- Encourages community (public and private) support and participation through education and public outreach.
- Static, the strategic plan has been and will continue to be a living document constantly updated as new information becomes available.

This strategy is not:

- A Regulation to be imposed on landowners.
- A means to prevent anyone from undertaking restoration projects with their own funds.
- An implementation plan that mandates certain projects be done.
- A way to avoid or fully address the requirements of the Endangered Species Act.
- The only option available to halt the decline of salmon in Pacific County (WRIA 24).

2.0 Introduction

2.1 Historical Perspectives and Conditions

Settlers began migrating to the Willapa Bay area in the 1850's. They referred to the bay that we now call Willapa Bay as Shoalwater Bay due to its shallow nature. The name was changed to Willapa Bay during the 1890's. The new settlers to the land quickly discovered that the timber covering the hills was a valuable commodity. Soon settlers began coming in larger numbers to the Willapa Bay area to log the land and make their fortunes. Small communities began appearing in the landscape (Willapa Alliance 1996).

The oyster industry of Willapa Bay saw a tremendous boom during the San Francisco Gold Rush. There was a great demand for oysters in San Francisco, and stories were told of oysters being paid for with gold. The sight of oyster schooners gathering their bounty, white sails flashing in the sun, soon became a common sight. The native oyster population was decimated by the 1880's due to over harvesting (Willapa Alliance 1996). After attempts at renewing the oyster population with plantings of Eastern oysters failed, the Japanese oyster was found to adapt well to the brisk waters of Willapa Bay. The seeds of the Japanese oysters revitalized the oyster industry of Willapa Bay, and today the oyster industry provides employment for many Pacific County residents (Willapa Alliance 1996).

The Willapa Basin covers more than 1000 square miles including the Willapa Bay estuary with over 100 miles of shoreline. The dominant habitat is coastal temperate forest consisting of primarily western hemlock and Douglas fir. Other habitats include dune and sea cliff grasslands, coastal pine forests, extensive salt and freshwater marshes and Sitka spruce swamps. The Willapa watershed is the most productive coastal ecosystem remaining in the continental United States. The Pacific Flyway crosses the Willapa Basin and is a major feeding and resting area for migrating shorebirds, waterfowl and other species. Its eel grass beds and marshlands provide critical habitat for 70 species of migratory birds (Willapa Alliance 1996).

The Willapa tide flats make up a quarter of the productive shellfish growing waters in the western United States (Willapa Alliance 1996). Today Willapa's economy is based on its rich natural resources. Nearly two-thirds of the land in the watershed is commercial forest lands. Farms make up another seven percent including 1400 acres of bogs that produce virtually all of the state's harvest of cranberries (Willapa Alliance 1996). Pacific Salmon, Dungeness crab and several species of clams also abound in the bay. Oysters are cultivated on nearly 10,000 acres of privately owned or leased tidelands. One of every six oysters consumed in the United States was grown on Willapa tideflats (Willapa Alliance 1996).

Commercial fishing has always been an integral part of the local economy. Salmon generally account for more than 90 percent of the finfish caught in Willapa's waters. Recently, chinook and coho harvests have been above historic averages. However, native chum runs are critically low (Willapa Alliance 1996).

2.2 Ecosystem Conditions

The Willapa region, as most rural northwest communities, bases its economy on harvest of natural resources. Here, these include timber, fish, shellfish, and agricultural products. The wealth for both large and small landowners lies in the productivity of the land and waters.

However, no other organism links the local community so closely to nature in the Pacific Northwest as the salmon. Historically streams of the Willapa region have been productive salmon bearing waters. This is particularly true of small lowland streams and wetlands. These streams provide important spawning and rearing habitat for native salmonids. Salmonid species utilizing these waters consist of sea-run cutthroat trout *(Oncorhynchus clarki),* steelhead trout *(O. mykiss),* coho salmon *(O. kisutch),* Chinook salmon *(O. tshawytscha),* and chum salmon *(O. keta)*.

Salmon have significant scientific, cultural, and economic value to the people of the Pacific Northwest. In addition to the importance of salmon fishing to our local economy salmon populations are considered ecological integrity indicators of the ecosystems we inhabit (Kitsap County 2000). In spite of the important scientific, cultural, and economic value of these salmon runs can be improved.

Recent research on the linkage between ocean conditions and salmon runs indicates that while local ocean conditions may be improving, regional runs continue to be affected by other factors such a loss of spawning areas, stream blockages, decreased genetic diversity, reduced stream productivity, and loss of rearing habitat for young fish.

Recently implemented forest and fish rules (Forest Practices Rules WAC-222) have dramatically changed timber harvest in the vicinity of creeks and streams. Stream buffer widths are now increased along with timber removal limits within riparian areas. These improvements promote the overall preservation of the riparian corridor and stream integrity. Direct impacts to stream temperature, large woody debris recruitment, and erosion, are now reduced. Environmental benefits of the regulatory change put into effect in March of 2000 will not necessarily be seen for several years or even decades as previously logged streams and riparian corridors recover.

2.3 Future Priorities

Recovery of naturally spawning salmon populations will require preserving and protecting remaining habitat, as well as restoring already degraded systems. This can be achieved in part by removing migration barriers, protecting and restoring riparian habitat, reducing sediment loads, and replenishing stream productivity (Willapa Indicators 1998).

Currently, the majority of the streams in the Willapa Basin support salmon, only a portion cannot. Wherever salmon passage is obstructed whether due to roads, culverts, or tide gates restoration efforts to clear the way for fish to migrate upstream are crucial (Willapa Indicators 1998).

Protecting and restoring habitat includes preventing the degradation of riparian areas that currently provide and protect important salmon habitat. Important characteristics of salmon habitat include shade, large woody debris, and stream bank stability. In disturbed riparian areas, planting coniferous trees can help stabilize the streambanks while providing shade for the stream.

Riparian vegetation also provides much of the organic material required to support biotic activity within the stream as well as the large woody debris needed to create physical structure, develop pool/riffle characteristics, retain gravel and organic litter, provide substrate, and moderate flood flows (Spence et al. 1996). Particular attention needs to be focused on steep and/or unstable slopes. These areas have a higher probability of slope failure and can deliver large amounts of sediment to the stream that can destroy important salmon habitat (The Willapa Alliance 1998).

One of the Willapa basins main limiting factors is the delivery of excess sediment to rivers and streams. This sediment is largely due to inadequately maintained roads. The Willapa watershed has an average of five miles of road per square mile. Regular maintenance or decommissioning older roads can effectively reduce the amount of sediment entering the streams. When constructing new roads, the implementation of Best Management Practices (BMP's) such as hay bales, rip rap pads, and filter fabric can dramatically decrease erosion (The Willapa Alliance 1998).

Recovery of wild salmonids requires habitat that is functional across the broader landscape (Frissell 1993). This means a cooperative effort that includes management plans, regulations, and voluntary actions must be implemented. If the following recovery plan can take steps to restore critical habitat needs, remove barriers, and increase salmonid populations, then the Willapa community may see a return to viable natural spawning that will in turn support the Willapa regions historic fishing industry for all salmon species.

3.0 Mission Statement, Strategy, Guiding Principles and Key Issues

3.1 Willapa Bay Water Resources Coordinating Council (WBWRCC) Mission Statement:

The WBWRCC mission, for salmon recovery, is to review, evaluate, and prioritize salmon habitat restoration and enhancement project proposals prior to their submission for funding to the state Salmon Recovery Funding Board. This will be accomplished within the guidelines established by the Lead Entity legislation and the process developed and approved by the members of the WBWRCC and the Pacific County Commissioners.

3.2 Willapa Bay Water Resources Coordinating Council Mission Strategy:

The WBWRCC strategy is to maintain and enhance the existing base of functional salmon habitat, encourage volunteer opportunities to restore and acquire lands for ecosystem function, and protect existing environmental health. The strategy involves local citizens working together to develop projects using a systematic, scientific, and adaptive approach to solving salmon habitat problems, based on the technical report *Salmon and Steelhead Limiting Factors in the Willapa Basin*, and other scientific data.

3.3 Willapa Bay Water Resources Coordinating Council Guiding Principles:

PRINCIPLE #1: **Using the best available information, target the most biologically important areas for salmon restoration and protection.**

For this Strategic Plan, salmonids are the species targeted for the recovery efforts. Using specific data on salmon and steelhead limiting factors and productivity within the Willapa basin, specific types of projects have been targeted for restoration and protection of habitat for these species (Smith 1999). Salmon and steelhead are targeted at this time because they are species for which we have the best site-specific data on limiting factors and productivity; and because of their similar life histories. The habitat preferences of these species comprise a wide range of habitat types in the basin and thus result in target areas generally consistent with the multiple-species recovery goals of the WBWRCC.

Successful and effective salmon habitat recovery can be only assured by completion of a comprehensive description of the watershed. Pacific County (WRIA 24) has completed watershed assessments of most of the subwatersheds (North, Willapa, Palix, Nemah, Naselle, Bear and Long Beach). Currently the Nemah and Naselle watersheds are undergoing a watershed assessment (WFPB 1996). These scientifically guided assessments, in addition to other independent studies, identify natural resource issues within the watershed as they relate to salmon habitat status and recovery. Defining the scientific basis and status of salmon habitat issues by watershed is essential to help project sponsors, watershed communities and funding agencies direct limited financial and human resources to the projects that best address the habitat needs of salmon stocks within specific basin or subbasins.

This Strategic Plan and the WBWRCC encourages projects that are consistent with these principles. The WBWRCC will also continue to accept for review projects throughout WRIA 24 that represent solutions to all salmon habitat related issues and their project specific merits. Many valuable and effective projects are possible that are not limited to those identified in this document as an immediate priority. If proposed, they will be evaluated and considered in kind. In these cases, submittals may be subject to further scrutiny. Applicants may be required to provide additional information and supporting justification that the project is compatible with the overall salmon recovery strategy. All applicants are encouraged to prepare their proposals based upon as much available scientific knowledge and literature pertinent to their project as possible.

PRINCIPLE #2: Within WRIA 24, enhance, restore and protect key habitat.

Numerous studies, reports, peer-reviewed journal articles and books, describe the importance of protecting those remaining areas of habitat that still retain a substantial measure of their historic, natural productivity for salmon and steelhead. These areas are generally known as refugia, source areas, anchor areas, or key habitats (Skagit Watershed Council 2000). In this report, these areas are generally referred to as key habitat. Key salmonid habitat, is defined in this document as, *under pristine conditions*, a habitat type critical for the survival of at least one salmonid life stage or is a preferred habitat type by a majority of life stages, containing adequate quantities of high quality, complex and connected habitat components as well as the bio-physical processes that maintain these natural conditions over the long-term (Kitsap County 2000).

However, protecting key habitats alone may not be sufficient to ensure long-term survival or recovery of salmon. Therefore, the reestablishment of key habitats in the target areas through a variety of restoration tools (e.g., culvert and tidegate removal, sediment reduction, riparian planting and fencing, isolated habitat reconnection, land acquisition, easements, etc.) is also encouraged. Restoration projects should occur simultaneous with protection efforts in order to 1) expand on the existing key habitat, and 2) enlarge and reconnect key habitat throughout the basin where these habitats have been largely removed or impaired, and are therefore considered to be limiting factors for various species. Depending on the current conditions in our target areas, different combinations of restoration and protection approaches will be appropriate. In some areas, protection actions will be dominant, while in more degraded areas, restoration actions may be dominant. The variety of tools to achieve restoration and protection is almost endless, with new advancements being made or discovered every day. The WBWRCC encourages project sponsors to seek expert advice in the various regulatory agencies or other professionals to capitalize on the advancing knowledge base.

PRINCIPLE #3: Do the most cost-effective projects first.

In order to ensure the best and most efficient use of funds for projects identified in these target areas, projects will be prioritized based on their cost-effectiveness. Cost effectiveness can and will be evaluated in several methods. Amount of habitat area involved in a particular project will be considered against cost. The amount and status of the key habitat types considered in any project will be judged against cost, and the anticipated chances of success will be compared to the habitat area, type and cost. Using the assessment criteria presented later in this document the WBWRCC will rate and rank project applications. Final decisions for funding prioritization will be made using all guiding principles.

PRINCIPLE #4: Encourage community (public and private) support and participation through education and public outreach.

Community support is essential for successful implementation of projects and projects should be designed and prioritized to build community support for overall recovery efforts. An informed, supportive and involved community can be a tremendous catalyst toward accomplishing salmon recovery goals.

Citizen committees are critical to ensure that priorities and projects have the necessary community support for success. They are often the best judges of current levels of community interests in salmon recovery and how to increase community support over time with the implementation of habitat projects. The complementary roles of both lead entity technical experts and citizen committees is essential to ensure the best projects are proposed for salmon recovery and that the projects will increase the technical and community support for an expanded and ever increasing effectiveness of lead entities at the local and regional level (from SRFB Funding Strategy, May 17, 2001).

Willing and participating landowners are also critical to the recovery of salmon in Pacific County WRIA 24. The recovery program must be focused upon sponsors and landowners willing to plan, develop and participate in salmon and steelhead recovery projects in all subbasins. Synergistic partnerships between stakeholders and applicants with the support of technical and regulatory personnel results in a well developed coordinated project. Having the local regulatory agencies supportive of recovery efforts is mandatory.

Communities can be made aware of the salmon recovery issues and their solutions through the media (newspaper articles, fliers, web pages), through observation of successful projects, workshops, and through word of mouth. For example, currently the WBWRCC is in the process of restoring the lower segment of Mill Pond Creek immediately west of South Bend. This project will be observed by all who travel in this vicinity on Hwy 101. In addition, South Bend High School students will be actively participating in the long term monitoring of this stream.

4.0 WRIA 24 Watershed Characteristics

4.1 Introduction

The Pacific County Strategic Salmon Recovery Plan includes a general discussion of salmon habitat elements and progresses through a description of each watershed, its characteristics, its limiting factors, general problems identified per each watershed, specific needs for each watershed and finally methods to address the specific needs. This general presentation is intended to provide a foundation of the current status of each watershed and basin included in this Plan. The base conditions and characteristics also provide initial direction to potential project sponsors, the general public and Technical Advisory Group. Major sections of the *Willapa Bay Strategic Salmon Recovery Plan,* prepared by Golder Associates, Inc. (2000) for the Pacific County Lead Entity and the *Salmon and Steelhead Habitat Limiting Factors in the Willapa Basin* prepared by Carol Smith of the Washington State Conservation Commission (1999) have been incorporated into this updated Salmon Recovery Plan. As stated earlier, the Pacific County Strategic Salmon Recovery Plan is a living, ever changing document. Information prepared and presented to the WBWRCC becomes immediately useful to those involved with salmon recovery.

4.2 Data Sources

Data sources reviewed for spawning and rearing habitat information included: The Salmon Habitat Enhancement and Restoration Division of WDFW maintains a database on fish passage problems (SSHEAR 1998). The Technical Advisory Group (TAG) also relied upon data contained in watershed analysis reports for the following watersheds: Little North River and Vesta Creek, Fall River, Willapa headwaters, and the Palix Basin. In addition to these published documents professional and personal knowledge of unpublished stream blockages identified and agreed-to within the TAG as well as recent survey data from the Pacific Conservation District was also included.

The Salmon and Steelhead Habitat Limiting Factors (1999) in the Willapa Basin by Carol J. Smith, Ph.D. was utilized to identify the major and minor habitat factors that limit salmonid production specifically within the Willapa basin. Detailed reports for each basin are discussed in the habitat section in this chapter. The Willapa Fisheries Enhancement Project (1992) by Bruce K. Suzumoto outlines salmonid distribution in the Willapa watershed as well as catch numbers, relative abundance and stock characteristics. In addition, the Physical and Biological Characteristics, and Salmonid Restoration Potential, of Seven Willapa National Refuge Waterbodies by the U.S. Fish and Wildlife Service was used to address the Long Island watershed (Barndt 2000).

The Columbia Pacific Resource Conservation and Development Council (1998) have developed a plan (A Watershed Level Conservation and Restoration Plan for the Bear River, Pacific County, Washington) that focuses on watershed level conservation and restoration of salmonids and other aquatic organisms. Many of the goals and objectives for the Bear River basin restoration are the same as those outlined here for the Willapa watershed restoration.

A document that also discusses many of the same salmon recovery goals and objectives as the Bear River Conservation and Restoration plan is A Vision for the Recovery of Willapa Salmon (1998) published by the Willapa Alliance. However, it includes all of the basins within the Willapa Bay watershed. In addition to the document itself there is also a related CD-ROM containing detailed natural resource information on the Willapa Bay watershed. This information was utilized throughout this document.

4.3 Critical Elements of Salmon Habitat

There are several critical elements of habitat required for every watershed to produce and support salmon. These critical elements are:

- Spawning and Rearing Habitat
- Floodplain Characteristics
- Streambed Sediment
- Riparian Conditions
- Water Quality and Quantity
- Estuarine Conditions

Please note that many of the recommended actions are being addressed at federal, state and local levels or being taken voluntarily by individual land owners. Because this is a living document to be used as guidance all of the available programs and activities available for habitat protection have not be addressed. This document has provided a general outline of principles and processes so that specifics can be identified at the time of implementation.

4.3.1 Spawning and Rearing Habitat

Free and unobstructed passage among habitat types is essential for most native spawning salmonids at all life stages. Fish passage is affected by both natural and man-made features and events. For example, high water temperatures may cause thermal migration blocks, drought or excessive sedimentation may result in flows too low for passage, and excessive turbidity or water velocity may deter passage. High flows may cause stranding as flows recede. Natural barriers such as waterfalls, cascades, and beaver dams are important features that contribute to variation within species and allow for species separation (i. e. anadromous vs. resident) (Fish and Wildlife Commission 1997).

Spawning site characteristics vary extensively between species and among stocks of the same species (Miller and Brannon, 1982). Studies indicate that a combination of factors are responsible for or influence the spawning habitat type and quality. These factors should be evaluated within each watershed and subbasin to define a range of acceptable conditions. Characteristics that influence site selection include geology (substrate type), stream bank slope, water velocity, water depth, bed compaction, dissolved oxygen, water temperature and vegetative cover.

The amount of available spawning habitat in the vicinity of spawning areas appears to be important criteria in spawning site selection. The amount of spawning habitat and number of spawners available at the time of spawning can limit the number of eggs successfully deposited, setting an upper limit on the size of the next generation and potentially acting as a density-dependent regulator of population size (Schuett-Hames and Pleus 1996).

Impairment of Spawning and Rearing Habitat by Human Activities

Throughout Washington, barriers have restricted or prevented juvenile and adult fish from gaining access to formerly accessible habitat. The most obvious of these barriers are human created structures such as dams, culverts, screens, tide-gates, and water quality and quantity fluctuations.

In recent years it has become increasingly clear that we have constructed barriers that prevent juveniles from accessing rearing habitat. Poorly designed culverts (undersized or not installed correctly) in streams have impacted the ability of coho juveniles to move upstream into rearing areas. In estuarine areas, dikes and levees have blocked off historically accessible estuarine areas such as tidal marshes.

4.3.2 Floodplain Conditions

Floodplains are portions of a watershed that are periodically flooded by the lateral overflow of rivers and streams. In general, most floodplain areas are located in the lowland areas of river basins and are associated with higher order streams. Floodplains are typically structurally complex, and are characterized by a great deal of lateral, aquatic connectivity by way of sloughs, backwaters, side channels, oxbows, and lakes. Often, floodplain channels can be highly braided (multiple parallel channels). One of the functions of floodplains is aquatic habitat. Aquatic habitats in floodplain areas can be very important for some species and life stages such as coho salmon juveniles that often use the sloughs and backwaters of floodplains to overwinter since this provides a refuge from high flows. Floodplains also help dissipate water energy during floods by allowing water to escape the channel and inundate the terrestrial landscape, lessening the impact of floods on incubating salmon eggs. Floodplains also provide coarse beds of alluvial sediments through which subsurface flow passes. This acts as a filter of nutrients and other chemicals to maintain high water quality.

Impairment of Floodplains by Human Activities

Large portions of the floodplains of many Washington rivers, especially those in the western part of the state, have been converted to urban and agricultural land uses. Much of the urban areas of the state are located in lowland floodplains, while land used for agricultural purposes is often located in floodplains because of the flat topography and rich soils deposited by the flooding rivers.

There are two major types of human impacts to floodplain functions. First, channels are disconnected from their floodplain. This occurs both laterally as a result of the construction of dikes and levees, which often occur simultaneously with the construction of roads, and longitudinally as a result of the construction of road crossings. Riparian forests were typically reduced or eliminated as levees and dikes are constructed. Channels can also become disconnected from their floodplains as a result of downcutting and incision of the channel from losses of LWD, decreased sediment supplies, and increased high flow events.

The second major type of impact is loss of natural riparian and upland vegetation. The natural riparian and terrestrial vegetation in floodplain areas was historically coniferous forest. Conversion of these forested areas to impervious surfaces, deciduous forests, meadows, grasslands, and farmed fields has occurred as floodplains have been converted to urban and agricultural uses. This has: 1) eliminated off-channel habitats such as sloughs and side channels, 2) increased flow velocity during flood events due to the constriction of the channel, 3) reduced subsurface flows, and 4) simplified channels since LWD is lost and channels are often straightened when levees are constructed. Elimination of off-channel habitats can result in the loss of important rearing habitats for juvenile salmonids such as sloughs and backwaters that function as overwintering habitat for coho juveniles. The loss of LWD from channels reduces the amount of rearing habitat available for chinook juveniles. Disconnection of the stream channels from their floodplain due to levee and dike construction increases water velocities, which in turn increases scour of the streambed. Salmon that spawn in these areas may have reduced egg to fry survival due to the scour. Removal of riparian zones can increase stream temperatures in channels, which can stress both adult and juvenile salmon. Sufficiently high temperatures can increase mortality.

4.3.3 Streambed Sediment Conditions

The sediments present in an ecologically healthy stream channel are naturally dynamic and are a function of a number of processes that input, store, and transport the materials. Processes naturally vary spatially and temporally and depend upon a number of features of the landscape such as stream order, gradient, stream size, basin size, geomorphic context, and hydrological regime. In forested mountain basins, sediment enters stream channels from natural mass wasting events (e.g. landslides and debris flows), surface erosion, and soil creep. Inputs of sediment to a stream channel in these types of basins naturally occurs periodically during extreme events such as floods (increasing erosion) and mass wasting which are the result of climatic events (e.g., rainstorms, rain on snow). In lowland, or higher order streams, erosion is the major natural sediment source. Inputs of sediment in these basins tend to be steadier in geologic time.

Once sediment enters a stream channel it can be stored or transported depending upon particle size, stream gradient, hydrological conditions, availability of storage sites, and channel type or morphology. Finer sediments tend to be transported through the system as wash load or suspended load, and have relatively little effect on channel morphology. Coarser sediments (>2 mm diameter) tend to travel as bedload, and can have larger effects on channel morphology as they move downstream, depositing through the channel network.

Some parts of the channel network are more effective at storing sediment, while other parts of the network are more effective at transporting material. There are also strong temporal components to sediment storage and transport, such as seasonally occurring floods, which tend to transport more material. One channel segment may function as a storage site during one time of year and a transport reach at other times. In general, the coarsest sediments are found in upper watersheds while the finest materials are found in the lower reaches of a watershed. Storage sites include various types of channel bars, floodplain areas, and behind LWD.

Effects of Human Actions on Sediment Processes

Changes in the supply, transport, and storage of sediments can occur as the direct result of human activities. Human actions can result in increases or decreases in the supply of sediments to a stream. Increases in sediment result from the isolation of the channel from the floodplain by development of lowland areas (diking and roading); this eliminates important storage areas for sediment. In addition, actions that destablize the landscape in high slope areas such as logging or road construction increase the frequency and severity of mass wasting events. Finally, increases in the frequency and magnitude of flood flows increases erosion. These increases in coarse materials fill pools and aggrade the channel, resulting in reduced habitat complexity and reduced rearing capacity for some salmonids. Increases in total sediment supply to a channel increases the proportion of fine sediments in the bed which can reduce the survival of incubating eggs in the gravel and change benthic invertebrate production.

Decreases in sediment supply occur in some streams. This occurs primarily as a result of disconnecting the channel from the floodplain. A dam can block the supply of sediment from upper watershed areas while a levee can cut off upland sources of sediment. Reduction in sediment supply can alter the streambed composition, which can reduce the amount of material suitable for spawning.

In addition to affecting sediment supply, human activities can also affect the storage and movement of sediment in a stream. An understanding of how sediment moves through a system is important for determining where sediment will have the greatest effect on salmonid habitat and for determining which areas will have the greatest likelihood of altering habitats. In general, transport of sediment changes as a result of the isolation of the channel from its floodplain. This increases in the magnitude and frequency of flood flows. Larger and more frequent flood flows moves larger and greater amounts of material more frequently. This can increase bed scour, bank erosions, and alter channel morphology, and ultimately degrade the quality of spawning and rearing habitat. Unstable channels become very dynamic and unpredictable compared to stable channels in undeveloped areas. Additional reductions in the levels of instream large woody debris (LWD) can greatly alter sediment storage and processing patterns, resulting in increased levels of fines in gravels and reduced organic material storage and nutrient cycling.

4.3.4 Riparian Conditions

Stream riparian zones are the area of living and dead vegetative material adjacent to a stream. They extend from the edge of the average high water mark of the wetted channel toward the uplands to a point where the zone ceases to have an influence on the stream channel. Riparian forest characteristics in ecologically healthy watersheds are strongly influenced by climate, channel geomorphology, and where the channel is located in the drainage network. For example, fires, severe windstorms, and debris flows can dramatically alter riparian characteristics. The width of the riparian zone and the extent of the riparian zone's influence on the stream are strongly related to stream size and drainage basin morphology. In a basin not impacted by humans, the riparian zone would exist as a mosaic of tree stands of different acreage, ages (e.g. sizes), and species. Functions of riparian zones include providing hydraulic diversity, adding structural complexity, buffering the energy of runoff events and erosive forces, moderating temperatures, and providing a source of nutrients. They are especially important as the source of large woody debris (LWD) in streams that directly influences several habitat attributes important to anadromous species. In particular, LWD helps control the amount of pool habitat and can serve as a site for sediment and nutrient storage. Pools provide a refuge from predators and high-flow events for juvenile salmon, especially coho that rear for extended periods in streams.

Effects of Human Activities on Riparian Zones

Riparian zones are impacted by all types of land use practices. In general, riparian forests can be completely removed, broken longitudinally by roads, and their widths can be reduced by land use practices. Further, species composition can be dramatically altered when native, coniferous trees are replaced by exotic species, shrubs, and deciduous species. Deciduous trees are typically of smaller diameter than coniferous forests and decompose faster than conifers, so they do not persist as long in streams and are vulnerable to washing out from lower magnitude floods. Once impacted, the recovery of a riparian zone can take many decades as the forest cover regrows, and coniferous species colonize.

Changes to riparian zones affect many attributes of stream ecosystems. For example, stream temperatures can increase due to the loss of shade, while streambanks can become more prone to erosion due to elimination of the trees and their associated roots. Perhaps the most important impact of riparian changes is a decline in the frequency, volume and quantity of LWD due to altered recruitment from forested areas. Loss of LWD results in a significant reduction in the complexity of stream channels including a decline of pool habitat, which reduces the number of rearing salmonids. Loss of LWD affects the amount of both overwintering and low flow rearing habitat as well as providing a variety of other ecological functions in the channel.

4.3.5 Water Quality and Quantity Conditions

The hydrologic regime of a drainage basin refers to how water is collected, moved and stored. The frequency and magnitude of floods in streams are especially important since floods are the primary source of disturbance in streams and thus play a key role in how they are structured and function. In ecologically healthy systems, the physical and biotic changes caused by natural disturbances are not usually sustained, and recovery is rapid to predisturbance levels. If the magnitude of change is sufficiently large, however, permanent impacts can occur.

Alterations in basin hydrology are caused by changes in soils, decreases in the amount of forest cover, increases in impervious surfaces, elimination of riparian and headwater wetlands, and changes in landscape context. Hydrologic impacts occur even at low levels of development (<2% impervious surfaces) and generally increase in severity as more of the landscape is converted to urban or open uses (Smith 1999).

Water Quality

The concentration of substances in stream water depends on many factors, including both natural and human introduced. Concentrations vary from stream to stream and from site to site on the same stream, depending on the geology, climate, soil and vegetation of the watershed (Adopt a Stream 1991). These concentrations also vary throughout the year from season to season, from day to day, and sometimes from hour to hour (Adopt a Stream 1991).

Many substances increase or decrease with the timing and quantity of runoff. During dry weather, streams receive much of their flow from surface and groundwater. Therefore the concentration of minerals and salts may be greater in dry times than during wet weather, when increased surface runoff and stream flow may dilute the concentration of substances. The chemical water quality of a stream is good if naturally occurring substances are present in the concentrations appropriate for that particular stream system.

Effects of Human Activities on Water Quality

Problems occur when human activity alters the concentrations of naturally occurring substances or introduce foreign substances that may be toxic to stream life (Adopt a Stream 1991). If there is erosion or a non-point pollution source in a watershed, increased surface runoff will carry increased concentrations of sediment and pollutants into the stream system (Adopt a Stream 1991).

Water Quantity

Maintaining flow is essential to habitat protection. In many regions stream segments are dewatered or impacted by withdrawals for irrigation, industrial and municipal supply; diversion for hydroelectric power; evaporation; and groundwater infiltration.

During low-flow conditions, impacts from point source discharges of chemical stressors are typically greatest, because effluent constitutes a larger percentage of (sometimes all) stream water at low flow.

Effects of Human Activities on Water Quantity

Impervious surfaces reduce the water storage capacity of a watershed. Watershed development increases impervious surfaces and creates an increase in runoff volume and velocity. Receiving waters (streams and rivers) experience a shift in water flow regime. Summer flow patterns tend to decrease and water temperature tends to increase. In winter, water flow will increase and erosion potential similarly increases. Increased erosion results in increased sedimentation and channel migration, as well as increased turbidity and suspended solids. Road construction is a very common measure of watershed development and poorly placed roads in relation to streams and rivers can increase water runoff and promote the resulting impairments.

Human activity has also resulted in an overall loss of wetland habitat that affects stream flow conditions. Wetlands provide many functions and one important function is to attenuate storm water impacts and to support low flow hydrology by releasing water into the drainage system over a longer time period.

4.3.6 Estuarine Conditions in WRIA 24

The Willapa Basin estuary consists of about 88,000 acres at mean high tide, with a complete water exchange every 2-3 weeks (The Willapa Alliance 1998). While toxins have not been identified as a problem in the region, *Spartina* invasion is significant. *Spartina* was introduced to Willapa Bay from the East Coast about 100 years ago, and the invasion increased dramatically in the last two decades (DOE 1997). It grows into a "meadow", covering the mudflats. This changes the composition of the mudflat dwellers, displaces native eelgrass, and raises the elevation of the flats. *Spartina's* impact on juvenile salmon rearing habitat, as well as the ecosystem upon which the young salmon depend is unknown, but the displacement of native eelgrass is a great concern. Eelgrass is important nursery habitat for juvenile salmonids. Juvenile salmon use the eelgrass to hide from predators, as well as feed on copepods that are living on the bacteria from decaying eelgrass (Levings 1985; Webb 1991).

Effects of Human Activities on Estuarine Conditons
Large woody debris in the estuary was common prior to logging and settlements, but is very low now. Estuarine LWD serves as vital cover for juvenile salmonids (Martin and Dieu 1997). The wood also creates firm substrates in a fine sediment environment, and spruce and cedar grew from nurse logs in the estuary. In estuary type habitat, the presence of LWD is necessary for riparian trees. It is also important substrate for wood dwelling invertebrates, which are an important prey item for juvenile salmonids.

4.4 Salmon Habitat In The Willapa Basin

The Willapa Basin (see Figure B.1) consists of seven watersheds that currently produce salmon: the North, Willapa, Palix, Nemah, Naselle, Bear, and Long Beach Watersheds. The largest river systems in the region are the North, Willapa, and Naselle systems (Smith 1999). The Cedar River Watershed historically supported low numbers of coho salmon and will also be addressed to a limited degree in this report.

In total, there are roughly 745 streams encompassing over 1470 linear stream miles in the Willapa region (Phinney and Bucknell 1975). Annual rainfall in the basin has averaged about 85 inches with a range of 44-145 inches and an average of three inches of rain per month during the summer (The Willapa Alliance 1998). No streams within the Willapa basin originate from glaciers; all depend on surface and ground water inputs. Therefore, precipitation plays an important role in the quantity and quality of salmon habitat. However, Willapa Bay salinity appears to be linked not only to the Willapa Basin drainages, but also to flow from the Columbia and Chehalis River basins (The Willapa Alliance 1998). Many salinity profiles for Pacific oast estuaries shows a peak in the summer and a low in the winter, but Willapa Bay salinity drops in the late spring when snowmelt in the Columbia and Chehalis Basins is emptying into the Pacific Ocean. The greatest source of freshwater for Willapa Bay is the Columbia River, the Willapa Bay ecosystem depends upon the maintenance of high water quality in the Columbia River.

Figure B-1 Location of WRIA 24

Figure B.2 illustrates salmonid distribution throughout the entire WRIA 24 (Smith 1999). Because the map was reduced in size to fit the report, it might be difficult to see the chum salmon spawning distribution. Wall maps are available electronically or can be viewed at the Pacific Conservation District or the Pacific County Department of Community Development. This report also addresses salmon and steelhead trout.

4.4.1 Limiting Factors, Gap Analysis, and Methods of Assessment by Watershed

The next section of this chapter identifies habitat problems within WRIA 24 (the Chinook River is addressed in the lower Columbia River report) by watershed. The limiting factors, general problems identified per each watershed, specific needs for each watershed and finally methods to address the specific needs are summarized. Sequencing the chapter in this way allows the reader to keep focus on each watershed as a whole from the identification of problems to possible corrective measures.

Limiting Factors*:*

In this report, limiting factors are defined as major and minor habitat factors that limit salmonid production. Engrossed Substitute House Bill 2496 defines limiting factors as, "conditions that limit the ability of habitat to fully sustain populations of salmon." The alterations of aquatic habitat are limiting factors. Human activities degrade and eliminate aquatic habitats by altering key natural processes.

Land use practices such as forestry, grazing, agriculture and urbanization disrupt aquatic ecosystems that ultimately influence the attributes of streams, lakes, and estuaries. Typical examples of human caused impacts leading to limiting factors include:

- Road Building
    - Increases runoff
    - Historic loss of riparian habitat (reduced shade, increases temperature)
    - Increased fine sediment inputs
    - Increased mass wasting (erosion, landslides)
    - Culverts, tide gates and blockages (logs, debris plugging)
- Logging
    - Road construction
    - Historic loss of riparian habitat (reduced shade, increases temperature)
    - Increased fine sediment inputs
    - Increased mass wasting (landslides)
- Agriculture
    - Loss of riparian habitat (reduced shade, increases temperature)
    - Increased fine sediment inputs

Figure B2 Salmonid Distribution

Gap Analysis:
The gap analysis, or needs assessment takes the limiting factors analysis (LFA), the next step. It provides a level of guidance specific to the type(s) of habitat protection and restoration work being implemented. For this report, the gap analysis has been segmented into a Completed Analysis section, a Needed Analysis section and an additional considerations section. The majority of this information was compiled by Golder Associates, Inc. in July of 2000 for the WBWRCC. Credit is given to them and the Washington State Conservation Commission.

Methods for Assessing Willapa Bay (WRIA 24) Sub-basins
The methods for assessing Willapa Bay (WRIA 24) sub-basins were taken directly from the *Willapa Bay Strategic Salmon Recovery Plan,* prepared by Golder Associates, Inc. (2000) for the WBWRCC. The needs identified in the Gap Analysis have been expanded upon to include identification of the need followed by a description of the activity and methodology to address the need.

4.4.2 Salmon Habitat Assessment in the Willapa Basin by Watershed

Cedar River
Cedar River Watershed
There are a number of small independent streams along the north shore of Willapa Bay, west of the North River. The Cedar River historically produced small runs of coho and chum salmon (Phinney and Bucknell 1975; Lonnie Crumley, WDFW, personal communication). It is a low gradient stream, draining the low hill area; most of the watershed is less than 400 feet in elevation (Phinney and Bucknell 1975). Its source is the south slope of Seastrand Ridge. The North Fork Cedar River provides most of the drainage.

Cedar River Limiting Factors
The Cedar River does not currently support salmon production. However, historically the Cedar River supported coho and chum salmon. Tidegates are a major habitat problem for this river. Documentation of other habitat issues was scant for this watershed. Improvement projects proposed in the Cedar River Watershed are considered low priority at this time.

Habitat concerns for specific sub-basins:

Cedar River

- The tidegate is the primary cause of the loss of historical salmon population.
- Blockages may limit juvenile salmon rearing habitat in the estuary

Cedar River Needs (Gap) Assessment

Completed Analyses

- ✓ Culvert Analysis

Needed Analyses

1. Augment Existing Tidegate Inventory – (fill gap)
2. Update Current Salmonid Distribution Maps
3. Assess and Produce Potential Salmonid Distribution Maps

Cedar River - Methods for Assessing Limiting Factors

Project	**Activity**	**Method**
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	1. Cross-Sectional Surveys 2. Empirical Sampling 3. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use Washington State Wetalnds Identification and Delineation Maual. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB

	Key Pieces of LWD per stream channel width.	1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

North River

North River Watershed

The North River and Smith Creek Watersheds drain into the northern portion of Willapa Bay, and are low gradient systems throughout their lower reaches. The North River drains nearly 229,000 acres (The Willapa Alliance 1998). Tidal influence occurs up to river mile (RM) 7.4 of the North River (Phinney and Bucknell 1975). The lower North River mainstem provides spawning and rearing habitat for winter steelhead trout, and chum, coho, and fall chinook salmon. Lower Salmon Creek is an important salmon-producing tributary with its headwaters in the hills southeast of the North River. It produces chum, fall chinook, coho salmon and winter steelhead trout. Fall chinook and chum salmon primarily use the lower 4 miles of Lower Salmon Creek, while coho salmon and steelhead trout can be found throughout the drainage (Herger 1997). Limited spawning and rearing habitat exists in Bitter Creek and the North Branch North River for fall chinook, coho, chum salmon, and winter steelhead trout (Herger 1997).

Upstream of the Highway 101 crossing, the North River is mostly a confined channel until its confluence with Vesta Creek, and spawning steelhead trout, fall chinook, coho, and chum salmon have been documented here. Chum salmon spawners have also been noted in various small tributaries that join the North River (Fig. B.2). In this area, two additional major tributaries, the Little North River and Salmon Creek, join the North River. Each supports winter steelhead trout and coho salmon spawning and rearing, as well as some fall chinook salmon spawning in the mainstem Little North River (to RM 10) and the lower 1.5 miles of Salmon Creek (Herger 1995). In the Little North River drainage, coho salmon and winter steelhead trout are also found in Mosquito Creek, Brick Creek, Beck Creek, and Black Creek (Herger 1995). Vesta Creek joins the North River at river mile 42.6 and is important for winter steelhead trout and coho salmon production, although chinook habitat exists in the lower 2 miles. It is mostly surrounded by timberland and has a very low gradient. The West and East Fork Vesta Creeks join to form Vesta Creek and both forks contribute to coho and winter steelhead production (Herger 1995).

Further upstream, the mainstem North River is utilized by fall chinook, chum, and coho salmon, and winter steelhead trout (Herger 1995). The Fall River joins the upper North River, and drains an area of about 41 square miles. Winter steelhead, coho, chum, and two different stocks of fall chinook have been documented in the Fall River drainage. One of the chinook stocks is a native early fall chinook, which use the lower 7 miles of mainstem Fall River (Herger 1995). Coho and winter steelhead use the majority of the mainstem Fall River as well as tributaries such as Moss and Boss Creeks (Fig. B.2) (Herger 1995). Chum salmon have been seen in the lower mainstem Fall River.

Near the headwaters of the North River are two other important drainages. Redfield Creek is important for coho salmon and winter steelhead production, while Raimie Creek produces coho and chinook salmon as well as winter steelhead trout.

Near the mouth of the North River is its largest tributary, Smith Creek, which drains 67.2 square miles (Phinney and Bucknell 1975). It is 27.9 miles long with over 84 lineal miles of tributaries. Smith Creek begins in the low hills northeast of Raymond, and is a low gradient stream. The lower 7 miles of mainstem provides spawning habitat for chum and fall chinook, while coho and winter steelhead habitat extends to RM 25 (Fig. B.2) (Lillian Herger, Weyerhaeuser, personal communication). Smith Creek tributaries such as Elkhorn, Clearwater, and Butte Creeks also produce coho salmon and winter steelhead trout.

North River Limiting Factors

Major habitat factors that limit salmon production in the North River Watershed include a current low level of large woody debris (LWD) throughout the basin, coupled with poor riparian conditions along the mainstem North, upper Little North, and Vesta Creek. Other major factors are excess sediment inputs from the dense network of roads, and loss of estuary habitat primarily due to dikes and tidegates. Less extensive problems include culverts throughout the freshwater coho salmon and steelhead trout areas, and channel incision, which has disconnected the river from its floodplain and associated salmon rearing areas. Peak water flows resulting from the young age of the surrounding forests are believed to contribute to channel incision. Channel incision is worsened by the lack of LWD.

Some areas (Vesta Creek, Little North River, and Redfield Creek.) have naturally low levels of gravel recruitment limiting available spawning habitat, and existing spawning habitat in this region should be protected. However, the current lack of LWD worsens the naturally low levels of spawning gravels. Pool habitat is below adequate levels, and is also a result of low LWD levels and channel incision. High summer water temperatures is another salmon habitat problem in this watershed, and poor shading from the altered riparian zones is one major cause of this problem.

Spawning gravels and LWD are lacking in Smith Creek basin. Previously, spawning gravel pads increased the level of spawners in these reaches, but these have been washed out or inundated by fines. Sedimentation is naturally high throughout the sub-basin, but is worsened by road-produced sediments and landslides.

General habitat concerns for the entire basin:

- Riparian conditions along the mainstream North, upper Little North, and Vesta Creek.
- Excess sediment inputs from the dense network of roads
- Culverts throughout the freshwater Coho salmon and steelhead trout areas
- Channel incision, which has disconnected the river from its floodplain and associated salmon rearing areas.
- High peak flows are a concern throughout the basin, and contribute to channel scour and channel incision
- Low levels of LWD and a low likelihood of near-term LWD recruitment
- Pool habitat is below adequate levels due to the low LWD levels and channel incision
- Peak water flows resulting from the young age of the surrounding forests
- High water temperatures. Certain tributaries are on the Washington State 303(d) List for exceeding water temperature standards.
- Loss of estuary habitat primarily due to dikes and tide gates.

Habitat concerns for specific sub-basins:

Lower North and Salmon Creek

- Two medium impact impassable culverts have been identified.
- Flood plain condition is poor due to dikes, floodgates, and channel incision
- Low levels of spawning gravel
- Low levels of LWD and a low likelihood of near-term LWD recruitment
- High road density in basin
- High water temperatures. Certain tributaries are on the Washington State 303(d) List for exceeding water temperature standards. (needs to be confirmed by a more in-depth study)

Smith Creek

- Loss of spawning gravel due to low levels of LWD
- High natural levels of sediment worsened by road-produced sediments and landslides
- Placed on the 1998 303(d) Candidate List for exceeding water temperature standards. (needs to be confirmed by a more in-depth study)

Vesta Creek and Little North

- Riparian conditions
- Channel is disconnected from floodplain due to channel incision
- Road-related mass wasting and sediment input
- Low levels of LWD and a low likelihood of near-term and long-term LWD recruitment

Fall River

- Floodplain and off-channel rearing reduced by moderately to tightly confined channel
- High levels of fine sediment associates with road-related mass wasting and road surface erosion
- Low levels of LWD
- Riparian conditions

<u>Appropriate Restoration Activities:</u>

Roads in this watershed contribute substantially to a high level of fine sediment, a high rate of mass wasting events, loss of off-channel rearing habitat, and reduction of available riparian forest vegetation. Projects to decommission roads, or improve them to reduce sediment production and the risk of slope failure would be appropriate restoration activities. The removal of culverts that block fish passage is important in providing access to additional salmon habitat.

Levels of LWD are quite low in this watershed. Furthermore, the majority of riparian forest is composed of early conifer and hardwood or open areas, so that LWD recruitment from the riparian areas is expected to be low in the near-term. Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, and creating pools and riffles for rearing habitat. The current lack of LWD worsens the naturally low levels of spawning gravel in Vesta Creek, Little North River, Smith Creek and Redfield Creek. Protection of existing spawning habitat in this region would be appropriate.

Planting of conifers would also be appropriate in riparian areas that are open or dominated by hardwoods. A protection strategy would be appropriate for the small amount of mature forest that remains in this watershed.

Dike removal and estuarine restoration would be an appropriate restoration activity to increase estuarine rearing habitat. Estuarine improvements should address the relationship to spawning habitat. A protection strategy would be appropriate for the estuarine wetlands that are intact and healthy.

North River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability Assessment
- ✓ Road Inventory
- ✓ Turbidity Assessment
- ✓ Riparian Shade Assessment

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment
5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows

9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Culvert Inventory – (fill gap)
13. Augment Existing Tidegate Inventory – (fill gap)
14. Update Current Salmonid Distribution Maps
15. Assess and Produce Potential Salmonid Distribution Maps

North River – Methods for Assessing Limiting Factors

Project	**Activity**	**Method**
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	4. Cross-Sectional Surveys 5. Empirical Sampling 6. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use <u>Washington State Wetalnds Identification and Delineation Maual</u>. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream	Assess current vegetation age and type and determine and compare with natural conditions. Assess how	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND

flows.	these changes have affected flows.	SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

Willapa River

Willapa River Watershed

The Willapa Watershed includes the Willapa River and its tributaries, which account for about 167,740 acres (The Willapa Fisheries Recovery Team 1996). It supports fall chinook, coho, fall chum salmon and winter steelhead trout. Major tributaries known to support salmon include the South Fork Willapa River, Trap Creek, Mill Creek, Wilson Creek, Fork Creek, and Ellis Creek. Smaller tributaries that produce salmon or steelhead are discussed below (Smith 1999).

The lower Willapa River flows through the cities of Raymond and South Bend. This area of the river is tidally influenced. Marsh grass habitat exists in the side sloughs, and is important rearing and transitional habitat for chinook and chum salmon. Very little spawning habitat is present in the mainstem until about RM 7 (Phinney and Bucknell 1975), although tributaries to Skidmore Slough produce coho and chum salmon (Tom Gibbons, DNR, personal communication).

The South Fork Willapa River joins the Willapa River at about RM 7.1. It is important for spawning, rearing and as a migration corridor for fall chinook, coho, winter steelhead, and fall chum. Chum salmon use the lower 5-6 miles of the South Fork Willapa River, while Chinook salmon use the lower 12 miles. Salmonids spawn throughout the South Fork Willapa River as well as in Rue Creek, a major tributary to the South Fork, which enters the South Fork Willapa at RM 9.7.

Wilson Creek enters the Willapa River at RM 12.1. This watershed contains over 11 miles of mainstem, and is a low velocity, low gradient stream (Phinney and Bucknell 1975). Winter steelhead trout, and coho and chum salmon spawn in Wilson Creek, and coho salmon have been documented in Whitcomb Creek. Steelhead trout have also been noted in Ward Creek and Fairchild Creek.

From the confluence with Mill Creek (RM 17.9) to its headwaters, the gradient of the Willapa River changes from moderate to high. Important salmon-producing tributaries in this region include Mill Creek, Stringer Creek, Trap Creek, and Forks Creek. Mill Creek supports winter steelhead, coho salmon, and low numbers of chum and fall chinook salmon. Trap Creek and Forks Creek drain into the Willapa River at RMs 29.9 and 30.5, respectively. Chinook and chum salmon and winter steelhead trout have been documented in the lower reaches, while coho salmon have been noted throughout Trap Creek (Fig. B.2) (Phinney and Bucknell 1975). Forks Creek provides habitat for chinook and coho salmon and steelhead trout. Steelhead and coho are also found in Ellis Creek, and coho are found in many small tributaries, such as Silver, Green, and Noe Creek.

A Washington Department of Fish and Wildlife salmon hatchery is located on Forks Creek, rearing and releasing fall chinook and coho salmon. The fall chinook are believed to be a mixture of native and non-native stocks (Green River, Spring Creek, Elochomin, Klickitat stocks) (Ashbrook and Fuss 1996). Two different stocks of coho are released from the facility: fall coho that were originated from native stock, although introductions have occurred throughout the years, and late coho from the Satsop River (Ashbrook and Fuss 1996).

The upper Willapa mainstem serves as spawning habitat for chinook, chum, coho, and steelhead. Chum, chinook, and coho salmon have also been found in Half Moon Creek, while coho salmon have been noted in Fern, Custer, Penny, and Falls Creeks.

Willapa River Limiting Factors
The lack of LWD is a major habitat problem for salmon throughout the Willapa Watershed. The Willapa watershed also has the highest density of roads, the greatest number of roads that cross streams, and the greatest quantity of roads in the riparian areas within the WRIA. Mass wasting sites are numerous, and combined with the road density, worsen sediment loads within the basin. The sedimentation is believed to contribute to filling (reducing) pool habitat and increasing fines, scour, and channel incision. High levels of fine sediment are a problem in the mainstem and north tributaries. These areas also have naturally low recruitment of spawning gravels, a condition that is worsened by the lack of LWD to store gravel. Scour is a significant concern in the upper mainstem, Stringer Creek, Ellis Creek, Trap Creek, and Forks Creek. Poor riparian conditions are major problems throughout the mainstem as well as in some tributaries (see Riparian Chapter for details). Other major limiting factors include high water temperatures and low dissolved oxygen in the summer months, as well as tidegates, which are barriers to estuary habitat.

Less extensive habitat problems include culverts throughout the freshwater habitat and dikes in the lower mainstem. Channel incision throughout the mainstem has further segregated the channel from historical rearing areas, and incision to bedrock has contributed (along with the lack of LWD) to few available pools for salmon. The incision is worsened by the lack of LWD and the increased sediment load from mass wasting and roads. Water turbidity is a problem in upper Fern Creek, and low flows are a problem in the upper mainstem Willapa. Stringer Creek is impacted by water withdrawals, and the dam prevents the downstream recruitment of spawning gravels. About 19% of the estuary habitat has been lost due to dikes for urban development and roads that act as dikes.

Habitat Concerns

- High road density throughout basin
- High level of fine sediments and many mass wasting events associated with roads
- High levels of streambed scour due to high winter flows in the upper main stem, Stringer Creek, Ellis Creek, Trap Creek, and Forks Creek
- Riparian conditions
- Channel incision and floodplain loss
- Low levels of LWD and a low likelihood of near-term LWD recruitment
- Certain stream sections are on the Washington State 303(d) List for exceeding water temperature and dissolved oxygen standards (not verified by in-depth data.
- Estuary loss due to dikes, tidegates, and roads

- Low water quantity in some tributaries in the summer months. Not verified by in depth data.
- Fish blockages have also been identified.

Appropriate Restoration Activities:
The road density and the number of riparian roads in the Willapa River watershed is the highest in WRIA 24. Roads in this watershed contribute significantly to several habitat concerns. They are associated with high levels of fine sediment, a high rate of mass wasting events, loss of off-channel rearing habitat, and reduction of available riparian forest vegetation. Roads that cross streams or lie within the floodplain are a particular hazard. Projects to decommission roads, or improve them to reduce sediment production and the risk of slope failure would be appropriate restoration activities. The removal of the high and medium impact culverts is important in providing access to additional salmon habitat.

Levels of LWD are quite low in this watershed. Furthermore, the majority of riparian forest is composed of early conifer and hardwood or open areas, so that LWD recruitment is expected to be low in the near-term. Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, and creating pools and riffles for rearing habitat. Planting of conifers would also be appropriate in riparian areas that are open or dominated by hardwoods. Riparian buffers would have the added benefit of reducing water temperatures. A protection strategy would be appropriate for the small amount of mature forest that remains in this watershed.

Dike removal and estuarine restoration would be an appropriate restoration activity to increase estuarine rearing habitat. Estuarine habitat must be evaluated in relationship to spawning habitat. A protection strategy would be appropriate for the estuarine wetlands that are intact and healthy.

Willapa River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability
- ✓ Road Inventory
- ✓ Riparian Shade Assessment

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment

5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows
9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Culvert Inventory – (fill gap)
13. Augment Existing Tidegate Inventory – (fill gap)
14. Update Current Salmonid Distribution Maps
15. Assess and Produce Potential Salmonid Distribution Maps

Additional Considerations

The following assessments are typically discussed in the Limiting Factors Analysis, but only in reference to certain watersheds within the Willapa Basin. However, they were not specifically identified as data needs within this particular watershed.

Spawning Gravel Assessment
Turbidity Monitoring

Willapa River – Methods for Assessing Limiting Factors

Project	Activity	Method
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	7. Cross-Sectional Surveys 8. Empirical Sampling 9. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland	Identify, map and classify wetlands	Using NWI maps, aerial photographs, and

Inventory	based on hydrogeology and function.	interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use Washington State Wetalnds Identification and Delineation Maual. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

Palix River

Palix River Watershed

Short drainage systems and relatively large estuaries characterize the Palix region. The Niawiakum River enters Willapa Bay north of the Palix River and has suitable habitat for coho and chum salmon and steelhead trout (Phinney and Bucknell 1975; Martin 1997). The Palix River consists of a short mainstem (about 9.4 miles), formed by three forks joining in tidewater about 1.5 miles from the mouth. Of these three forks, the Canon River (middle fork) has the most salmon-producing habitat.

The North Fork Palix generally has a sand-dominated bottom with little spawning gravels (Martin 1997; WDFW and WWTIT 1994), except for about one mile below a series of falls that impede upstream migration of salmon. Coho salmon, chum salmon, and winter steelhead spawn in that one mile reach below the falls (Tom Gibbons, DNR, personal communication), as well as in the limited spawning gravels downstream. Chinook salmon have been documented in the lower reach.

The South Fork Palix has limited spawning gravel, and serves primarily as rearing habitat for juvenile salmonids. Steelhead have been documented in the South Fork Palix. The lower two miles of the Canon River has a low gradient and plentiful spawning gravel, ideal for chum and fall chinook salmon (Phinney and Bucknell 1975; WDFW Spawner Survey Database). Spawning chinook have been documented up to RM 3.1 in the Canon River. The upper section of the Canon

River has large numbers of cascades, and supports coho salmon and winter steelhead trout (Martin 1997).

Palix River Limiting Factors

The primary salmonid habitat problems within the Palix Watershed include a significant lack of stable LWD, high road densities and road sediment inputs, extensive channel incision, and a high level of estuarine habitat loss. Gravel recruitment is fair within most channel segments of the Palix River, but incised channels require very large pieces of LWD, preferably with attached rootwads, to maintain the gravel within the needed areas. An increase in LWD would not only allow gravel storage, but would also serve to reverse the effects of channel incision by increasing instream bed elevations through gravel and sediment storage. The loss of estuarine wetlands habitat is extensive (at least 31% of historic estuarine wetlands area has been lost) primarily as a result of diking. Minor habitat problems include a small number of freshwater culverts where fish passage is impeded, and high water velocity in the winter, which could be improved with an increase of stable, very large, woody debris.

Habitat Concerns

- High road densities and road sediment inputs
- Extensive channel incision
- Loss of estuarine habitat, primarily as a result of diking
- High water velocity in the winter
- Low levels of LWD and a low likelihood of near-term LWD recruitment
- Habitat problems include a small number of freshwater culverts where fish passage is impeded

Appropriate Restoration Activities

Road densities are high in the Palix watershed and roads at stream crossings and in riparian areas contribute substantial sediment to streams. Removal of low impact culverts would be a minor (but important) restoration activity. Projects addressing the root cause of sedimentation would be appropriate.

Gravel recruitment is fair within most channel segments of the Palix River, but channel incision and high water velocities move gravel out of the system. Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, dissipating flood energy, and creating pools and riffles for rearing habitat.

The majority of the riparian forest is young or intermediate in age, so that natural recruitment of LWD is expected to be low in the near-term. Furthermore, incised channels require very large pieces of LWD (over two feet in diameter has been recommended for the Palix River), preferably with attached rootwads, to maintain the gravel within the needed areas. An increase in LWD would also serve to reverse the effects of channel incision by increasing in-stream bed elevations through gravel and sediment storage, thereby reconnecting the channel with the floodplain. Reconnecting the channel with the floodplain will increase off-channel rearing habitat.

Palix River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability
- ✓ Road Inventory
- ✓ Culvert Inventory
- ✓ Riparian Shade Assessment

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment
5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows
9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Tidegate Inventory – (fill gap)
13. Update Current Salmonid Distribution Maps
14. Assess and Produce Potential Salmonid Distribution Maps

Additional Considerations

The following assessments are typically discussed in the Limiting Factors Analysis, but only in reference to certain watersheds within the Willapa Basin. However, they were not specifically identified as data needs within this particular watershed.

Spawning Gravel Assessment
Turbidity Monitoring

Palix River _Methods for Assessing Limiting Factors

Project	**Activity**	**Method**
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	10. Cross-Sectional Surveys 11. Empirical Sampling 12. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use Washington State Wetalnds Identification and Delineation Maual. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

Nemah River

Nemah River Watershed

The Nemah River watershed contains 119 linear miles of mainstem and tributaries. It consists of three low gradient forks that flow into the central portion of Willapa Bay. The information presented in this section is preliminary and based upon work by Smith (1999). A watershed assessment is currently underway in the Nemah River. Updates will be made to this section when the watershed assessment of the Nemah is completed in the fall of 2001.

The North Fork Nemah River and its major tributary, Williams Creek, provides the most important salmon habitat in the watershed. The North Fork is about 12.4 miles long with a salmon hatchery at RM 4. The North Fork and Williams Creek also support natural production of fall chinook, coho, chum, and winter steelhead. Chum salmon use the lower sections, while chinook, coho and winter steelhead spawn throughout the mainstem. Coho and steelhead also use accessible tributaries.

The Middle Fork Nemah is about 10.2 miles long. The lower reaches are tidally influenced, while the middle reaches have steep gradients. The upper reaches flow through a broad valley. The lower reaches support chinook, coho, and chum salmon as well as winter steelhead trout, while chinook, coho, and steelhead have been documented further upstream. The South Fork is the smallest of the three forks, and supports limited chum, chinook, coho and winter steelhead. Coho salmon have been documented in Seal Slough, which is south of the South Fork Nemah River.

Nemah River Limiting Factors

In the North Nemah River, major problems include high inputs of fine sediment primarily from forest roads, poor riparian conditions, a lack of LWD, floodplain loss (mostly due to riparian roads), and road-related mass wasting. The Middle Nemah River also has poor riparian conditions and a lack of LWD. The sediment inputs are not currently major problems, but if the Middle Nemah A-Line road is used for logging again, it will likely become a significant sediment problem. This road has also resulted in a significant loss of floodplain area. Diking has resulted in considerable losses of estuarine wetlands habitat in the Middle Nemah. The South Nemah River is significantly impacted by diking of estuarine wetlands and a loss of riparian shade/canopy in the lower reaches. Freshwater barriers such as culverts are a problem, although not a major limiting factor throughout the Nemah system.

Habitat concerns

North Nemah River

- Major problems include high inputs of fine sediment primarily from forest roads. In addition, road-related mass wasting is a major problem.
- Riparian conditions.
- Low levels of LWD and a low likelihood of near-term LWD recruitment.
- Gravel storage capability is poor due to a low level of LWD
- Floodplain loss, mostly due to riparian roads
- One high impact culvert and two medium impact culverts have been identified on Type 3 and 4 habitat.

Middle Nemah River

- Riparian conditions
- Low levels of LWD and low likelihood of near-term LWD recruitment.
- Loss of floodplain area due to Middle Nemah A-Line road.
- Diking has resulted in considerable losses of estuarine wetlands habitat in the Middle Nemah.
- Middle Nemah A-Line road is also a potentially significant source of sediment.

South Nemah River

- Diking has resulted in considerable losses of estuarine wetlands habitat in the South Nemah.
- Sedimentation is a major problem due mainly to a high road density
- Low levels of LWD and low likelihood of near-term LWD recruitment.
- Riparian conditions and loss of riparian shade/canopy in the lower reaches.

Appropriate Restoration Activities:

Road density in the Nemah watershed is the second highest in WRIA 24, and the ratio of blockages per stream mile is the highest in WRIA 24. Roads in this watershed impact several habitat conditions, including sediment levels, floodplain loss, and reduction of available forest vegetation. Furthermore, they may act as dikes that contribute to scour and channel instability. Projects to decommission roads, or improve them to reduce sediment production and the risk of slope failure would be an appropriate restoration activity. In particular, roads that cross streams or lie within the floodplain are a particular hazard. The removal of high and medium impact culverts is important in providing access to additional salmon habitat. Removal of low impact culverts would be a minor (but important) restoration activity that could be coupled easily with road decommission projects.

Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, and creating pools and riffles for rearing habitat.

In general, estuary wetlands are relatively intact and in good condition in this watershed. However, the Middle and South Nemah Rivers have had substantial impacts due to diking. Dike removal and estuarine restoration would be appropriate in the Middle and South Nemah estuaries to increase estuarine rearing habitat. A protection strategy would be appropriate for the estuarine wetlands that are intact and healthy.

Nemah River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability
- ✓ Road Inventory
- ✓ Culvert Inventory

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment
5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows
9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Tidegate Inventory – (fill gap)
13. Update Current Salmonid Distribution Maps
14. Assess and Produce Potential Salmonid Distribution Maps

Additional Considerations

The following assessments are typically discussed in the Limiting Factors Analysis, but only in reference to certain watersheds within the Willapa Basin. However, they were not specifically identified as data needs within this particular watershed.

Spawning Gravel Assessment
Turbidity Monitoring

Nemah River – Methods for Assessing Limiting Factors

Project	**Activity**	**Method**
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	13. Cross-Sectional Surveys 14. Empirical Sampling 15. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM

		CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use Washington State Wetalnds Identification and Delineation Maual. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

Naselle River

Naselle River Watershed

The information presented in this section is preliminary and based upon work by Smith (1999). A watershed assessment is currently underway in the Naselle River. Updates will be made to this section when the watershed assessment of the Naselle is completed in the fall of 2001.

The lower Naselle River is heavily influenced by the tides, with large variations in size according to the tidal stage. Several tidal sloughs and marshes comprise the surrounding habitat. Ellsworth Creek drains into the lower Naselle, and this creek supports chum, chinook, and coho salmon as well as winter steelhead throughout the mainstem and larger tributaries. The lowest mile of this creek is also tidally influenced with a silt/sand bottom. Upstream, the gradient is moderate and spawning gravel is abundant.

Smith Creek joins the Naselle at RM 5.6 and supports chum spawning and rearing. Coho and chum salmon have been documented in Holm and Petes Creeks. Further upstream at RM 10.5, Dell Creek empties into the Naselle, and produces chum, coho, and winter steelhead (WDFW Spawning Ground Survey Database). Upstream of Dell Creek, the Naselle Watershed becomes a conglomerate of tributary systems. At the town of Naselle (RM 12), the South Fork Naselle empties into the Naselle River, and represents an additional 109.7 linear miles of stream drainage. Its left bank tributaries drain the Willapa Hills and have moderate gradients, while the right bank streams drain lowland farms. Coho, fall chum salmon, and winter steelhead spawn and rear throughout the mainstem. Major tributaries such as Davis Creek, Cement Creek, Burnham Creek, and Bean Creek also provide spawning and rearing habitat for coho and winter steelhead. Chum salmon have been found in Davis, Cement, and lower Bean Creeks.

Upstream at RM 14.1 is the confluence of Salmon Creek with the Naselle River. This tributary is just over 17 miles in length and has a low to moderate gradient. Fall chinook, chum, coho salmon and winter steelhead trout spawn throughout the mainstem. Winter steelhead, chinook, and coho also spawn in Russia Creek, a tributary to Salmon Creek at RM 8.4.

Important salmon spawning, rearing, and transportation habitat for fall chinook, and coho salmon, and winter steelhead trout is found throughout the remaining upper Naselle (Fig. B.2). This area is sometimes referred to as the East Fork, and much of the mainstem is confined within a bedrock canyon. The North Fork Naselle enters the mainstem at about RM 26 and is a moderately steep stream that flows through bedrock canyons. Fall chinook, coho salmon, and winter steelhead spawn in the mainstem North Fork as well as nearby Brock Creek, while coho and steelhead also use accessible tributaries such as Savage Creek (Phinney and Bucknell 1975; WDFW and WWTIT 1994). At RM 26.5, Alder Creek joins the Naselle and provides spawning and rearing habitat for fall chinook and coho salmon and winter steelhead trout.

Naselle River Limiting Factors

Major limiting factors throughout the Naselle Watershed include a lack of LWD coupled with poor riparian conditions (44% of the riparian consists of hardwoods, open, or young conifer). An exception to this is the mature forest in the East Fork Naselle, a critical habitat area that contributes to important salmon habitat functions. Other major habitat problems include a large number of culverts, tidegates, and riparian roads. Another extensive problem is sedimentation stemming primarily from a large number of landslides and secondarily from roads, particularly in Salmon Creek. Another major habitat problem for salmon is high water temperatures in the summer months. Lesser problems include estuary loss due to diking, as well as concerns about the possible change in flows due to the watershed condition, with higher high flows and lower low flows as the hydrologic maturity of the surrounding forest is reduced.

Habitat Concerns

- Low levels of LWD and a low likelihood of near-term LWD recruitment
- Riparian conditions
- A large number of culverts, tidegates, and riparian roads
- Sedimentation stemming primarily from a large number of landslides and secondarily from roads
- Estuary loss due to diking
- Three high impact culverts and one medium impact culvert have been identified

Appropriate Restoration Activities:

The road density in the Naselle watershed is very high, and the ratio of blockages per stream mile is the second highest in WRIA 24. Roads in this watershed contribute significantly to several habitat concerns, including high sediment levels, loss of off-channel rearing habitat, and reduction of available riparian forest vegetation. Projects to decommission roads, or improve them to reduce sediment production and the risk of slope failure would be appropriate restoration activities. In particular, roads that cross streams or lie within the floodplain are a particular hazard. The removal of the high and medium impact culverts is important in providing access to additional salmon habitat.

Gravel production is good in this watershed, but low levels of LWD reduce gravel storage capacity. The majority of riparian forest is composed of early conifer and hardwood or open areas, so that LWD recruitment is expected to be low in the near-term. Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, and creating pools and riffles for rearing habitat. Planting of conifers would also be appropriate in riparian areas that are open or dominated by hardwoods. A protection strategy would be appropriate for the small amount of mature forest that remains in this watershed.

In general, estuary wetlands are relatively intact and in good condition in this watershed, although diking has reduced the amount of estuarine habitat from historical levels. A protection strategy would be appropriate for conserving estuarine salmon habitat.

Naselle River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability
- ✓ Road Inventory

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment
5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows
9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Culvert Inventory – (fill gap)
13. Augment Existing Tidegate Inventory – (fill gap)

14. Update Current Salmonid Distribution Maps
15. Assess and Produce Potential Salmonid Distribution Maps

Additional Considerations

The following assessments are typically discussed in the Limiting Factors Analysis, but only in reference to certain watersheds within the Willapa Basin. However, they were not specifically identified as data needs within this particular watershed.

Turbidity Monitoring
Spawning Gravel Assessment

Naselle River – Methods for Assessing Limiting Factors

Project	**Activity**	**Method**
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	16. Cross-Sectional Surveys 17. Empirical Sampling 18. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use Washington State Wetalnds Identification and Delineation Maual. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including	Use TFW-EMEP 1998 RIPARIAN STAND

	canopy shade	SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

* Not finalized, methods still being researched and evaluated.

Bear River

Bear River Watershed

The Bear River drainage is relatively small, about 12.6 miles of mainstem with an additional 30.7 lineal miles of tributaries. The drainage area comprises about 30 square miles, and is the southernmost watershed emptying into Willapa Bay. The lower 3.5 miles is tidally influenced, and surrounded by marsh and deciduous brush. This area supports salmonid rearing and chum spawning. Further upstream, the gradient increases to become moderate and provides spawning and rearing habitat for chum, fall chinook, coho and winter steelhead (Phinney and Bucknell 1975; WDFW and WWTIT 1994). In the upper reaches, the uplands are mountainous with steep tributaries, providing spawning and rearing habitat for coho and winter steelhead.

Bear River Limiting Factors

Major salmonid habitat problems in the Bear River Watershed include a lack of LWD, excessive sedimentation from landslides and roads, and a large loss of estuarine habitat. Less significant habitat problems include an immature riparian forest, which consists of young conifer and will take time to mature, as well as a concern that the reduction in hydrologic maturity is resulting in possible higher high flows and lower low flows. Culverts are few in number, but those that block salmon access should be considered a minor restoration activity.

<u>Habitat Concerns</u>

- Low levels of LWD
- High level of sediment and mass wasting associated with roads
- Estuary loss due to diking
- High road density
- Poor riparian conditions

<u>Appropriate Restoration Activities:</u>

Specific restoration projects are identified in the *Bear River Conservation and Restoration Plan* (Lebovitz 1998) produced for the U.S Fish and Wildlife Service. The road density in the Bear River watershed is very high, and the density of riparian roads is the highest in WRIA 24. These roads contribute substantially to the high sediment levels, loss of off-channel rearing habitat, and reduction of available riparian forest vegetation. Projects to decommission roads, or improve them to reduce sediment production and the risk of slope failure would be appropriate restoration activities. Removing or replacing road culverts that limit or block fish passage would also be an important and appropriate activity.

Placement of LWD in areas that are gravel deficient would be an appropriate strategy for capturing, stabilizing, and storing spawning gravel, reducing sediment, and creating pools and riffles for rearing habitat. The *Bear River Conservation and Restoration Plan* (Lebovitz 1998) identifies stream reaches that would benefit most from LWD placement.

The planting of conifers would be appropriate in riparian areas that are open or dominated by hardwoods. A protection strategy would be appropriate for the small amount of mature forest that remains in this watershed.

Estuarine wetland loss has been extensive in the Bear River watershed, primarily due to diking and draining. Dike removal and estuarine restoration would be an appropriate restoration activity to increase estuarine rearing habitat. Some of this estuarine restoration activity is currently underway in a project implemented by USFWS. A protection strategy would be appropriate for the estuarine wetlands that are intact and healthy.

Bear River Needs (Gap) Assessment

Completed Analyses

- ✓ Off-Channel Habitat Availability
- ✓ Road Inventory
- ✓ Culvert Inventory

Needed Analyses

1. Sediment Budget
2. Substrate Analysis (includes Bank Slope Stability Assessment & Landslide Hazard Inventory
3. Scour Monitoring
4. Pool Habitat Assessment
5. Freshwater Wetland Inventory
6. Large Woody Debris Analysis
7. Riparian Assessment
8. Assessment of Changes in Vegetation Age and Type and Effects on Flows
9. Summer Temperatures Assessment
10. Summer Dissolved Oxygen Assessment
11. Assess Loss of Floodplain Habitat
12. Augment Existing Tidegate Inventory – (fill gap)
13. Update Current Salmonid Distribution Maps
14. Assess and Produce Potential Salmonid Distribution Maps

Additional Considerations

The following assessments are typically discussed in the Limiting Factors Analysis, but only in reference to certain watersheds within the Willapa Basin. However, they were not specifically identified as data needs within this particular watershed.

Spawning Gravel Assessment
Turbidity Monitoring

Bear River – Methods for Assessing Limiting Factors

Project	Activity	Method
Sediment Budget	Quantify rates of sediment production, transport and storage and overall output.	19. Cross-Sectional Surveys 20. Empirical Sampling 21. Modeling Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E).
Substrate Analysis	Assess levels of fine and coarse stream sediments. Conduct Landslide Hazard Inventory and Bank Stability Assessment.	Use grain size distribution analysis (Sieve). Use Wolman Pebble Count. Use TFW-AM9-006.1999 GRAVEL COMPOSITION SURVEY. Use WFPB 1997 Watershed Analysis MASS WASTING ASSESSMENT (MODULE A). Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT – Bank and Riparian Conditions (MODULE E).
Scour Analysis	Assess levels of sediment scour from streambeds and streambanks within identified stream reaches.	Use TFW-AM9-008.1999 SALMONID SPAWNING GRAVEL SCOUR SURVEY.
Pool Habitat Assessment	Assess pool spacing, frequency, area, sediment distribution, total numbers of free and forced pools and assess pool-forming factors.	Use TFW-AM9-003.1999 HABITAT UNIT SURVEY. Use WFPB 1997 Watershed Analysis STREAM CHANNEL ASSESSMENT (MODULE E) and FISH HABITAT (MODULE F).
Freshwater Wetland Inventory	Identify, map and classify wetlands based on hydrogeology and function.	Using NWI maps, aerial photographs, and interviews determine the locations of wetlands. Classify wetlands primarily using HGM approach and NWI and FPB methods, according to WFPB 1997 Watershed Analysis Manual WETLANDS CLASSIFICATION METHODS. Use <u>Washington State Wetalnds Identification and Delineation Maual</u>. Ecology Publication number 96-94 WA DOE 1997.
Large Woody Debris Analysis	Quantify overall levels of Large Woody Debris, measure and count Key Pieces of LWD per stream channel width.	Use TFW-AM9-99-004.1999 LARGE WOODY DEBRIS SURVEY. Use WFPB 1997 Watershed Analysis FISH HABITAT (MODULE F).
Riparian Assessment	Assess riparian conditions including canopy shade	Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION

		ASSESSMENT (MODULE D).
Assessment of Changes in Vegetation Age and Type and Effects on in-stream flows.	Assess current vegetation age and type and determine and compare with natural conditions. Assess how these changes have affected flows.	*Use USDA Forest Service's FOREST VEGETATION SIMULATOR (FVS). Use TFW-EMEP 1998 RIPARIAN STAND SURVEY. Use WFPB 1997 Watershed Analysis Manual RIPARIAN FUNCTION ASSESSMENT (MODULE D).
Summer Temperatures Assessment	Assess summer temperatures and the related causes and effects.	Use TFW-AM9-005.1999 STREAM TEMPERATURE SURVEY and/or WFPB 1997 Watershed Analysis Manual WATER TEMPERATURE ASSESSMENT (MODULE G).
Summer Dissolved Oxygen Assessment	Assess summer dissolved oxygen levels and the related causes and effects.	Use WFPB 1997 Watershed Analysis Manual DISSOLVED OXYGEN ASSESSMENT (MODULE G)

- Not finalized, methods still being researched and evaluated

Long Island and Long Beach

Long Island and Long BeachWatersheds

The Long Island and Long Beach Watersheds include the 5,403 acre island of Long Island and the 33,109 acres of the Long Beach peninsula. These areas are primarily utilized for tourism and port access.

Long Island Watershed

In August and October of 1999 five Long Island watershed streams: Riekkola, Lewis, Porter Point, Long Island Cedar Grove, and Headquarters were surveyed. These surveys measured habitat quantity and quality; fish species composition and relative species abundance; and macroinvertebrate species composition. Also two freshwater ponds on Long Island (North Centerline Pond and South Centerline Pond) were surveyed to determine species composition (Barndt et. al. 2000).

Reikkola Creek

Habitat suitable for salmonids, especially spawning substrate, is non-existent in the surveyed section of Reikkola Creek. Suitable habitat may exist in the upper drainage on its west side, the city of Long Beach's dam precludes fish passage to this habitat (Barndt et. al. 2000).

Lewis Creek

The presence of cutthroat indicate that habitat in this stream is suitable for salmonid spawning and rearing, despite the dominance of fine sediments in the substrate. Large marsh areas downstream of the the sampled areas provide important additional rearing and over-wintering habitat. Therefore, maintaining wetlands in the lower portion of this creek will benefit fish populations (Barndt et. al. 2000).

A recent clearcut timber harvest has left no riparian buffer on the private timberland immediately upstream of the surveyed reach. Impacts from clearcuts include the following: reduced LWD input, fine sediment influx and associated filling of pools and spawning gravels, increased summer and lower winter temperatures and increased peak water discharges (Barndt et. al. 2000).

Porter Point Creek

As in Lewis Creek the presence of cutthroat indicate that this stream has habitat suitable for salmonid spawning. Although the reach of stream sampled appeared to be limited by substrate unsuitable for salmonid spawning and by severely limited pool habitat, cutthroat were relatively abundant in this reach. This indicates that suitable spawning substrate is available upstream or elsewhere in the drainage, and that the reach surveyed is primarily rearing habitat; or that cutthroat were able to successfully reproduce in isolated pockets of gravel within the surveyed reach. Without surveying the upstream habitat it cannot be determined if habitat in this stream is suitable for other salmonid species (Barndt et. al. 2000).

Clearcut timber harvest upstream appears to be having similar effects on the surveyed reach as those described for Lewis Creek especially increased sedimentation. The lack of pool habitat in this reach may be caused by the deposition of sediment from upstream filling in pools. The abundance of LWD in this area may account for the abundance of cutthroat, as LWD may reduce some of the negative effects of timber harvest (Barndt et. al. 2000).

Long Island Cedar Grove Creek

The limited presence of coho indicates that either limited reproduction is occurring in the stream, or occasional fish are immigrating into the stream to rear from nearby streams. Despite the apparent suitability of the riparian vegetation and instream structure for coho and cutthroat this stream does not appear to support reproducing populations of salmonids. However, chum would not have been present in this stream during the sampling period as chum emigrate from the streams very soon after emergence from the gravel in the spring. In 1970 USFWS personnel sampled this stream and captured juvenile coho and cutthroat indicating that this stream may have historically supported reproducing salmonid populations. If so, subsequent land use practices may have extirpated these populations (Barndt et. al. 2000).

Headquarters Creek
As in Long Island Cedar Grove Creek, the limited presence of coho indicates that either limited reproduction is occurring in the stream, or occasional fish are immigrating into the stream. Habitat complexity is reduced in Headquarters Creek below the diversion dam, due in part to the relatively low amount of LWD present. The scarcity of off-channel rearing habitat and overwintering areas may also be limiting, especially for coho. Below the diversion dam, other parameters such as gradient, LWD, pool volume, and riparian cover, appear suitable for coho, cutthroat, and chum. The habitat above the diversion dam, especially the amount of pool habitat, is marginal for cutthroat. Overall, Headquarters Creek appears suitable for cutthroat, chum, coho. Therefore, the absence of cutthroat trout in this stream below the diversion dam is puzzling given the presence of this species in Porter Point Creek, a stream with more limiting habitat. However, after extensive timber harvest, habitat suitability may decrease to the point that cutthroat populations are unable to persist especially in competition with other fish (Barndt et. al. 2000).

Appropriate Restoration Activities

Reikkola Creek
There is no salmonid habitat restoration recommended in Riekkola Creek at this time. However, it is recommended that qualitative surveys of off-refuge tributaries on the east side of this drainage to determine if they contain potential salmonid habitat (Barndt et. al. 2000).

Lewis Creek
Salmonid management in this area should include restoration and conservation discussions with the managers of upstream spawning areas (Barndt et. al. 2000).

Porter Point Creek
Salmonid management of this stream should include discussions with the managers of upstream lands to encourage sound ecosystem management practices. In addition, the marsh areas downstream provide important additional rearing and overwintering habitat. Therefore, maintaining wetlands in the lower portions of these creeks will benefit fish populations (Barndt et. al. 2000).

Long Island Cedar Grove Creek
This stream has high value due to its biological integrity. Salmonid management of this stream should include coordination with the managers of upstream lands to encourage sound ecosystem practices such as selective cutting and riparian buffer strips (Barndt et. al. 2000).

Headquaters Creek
If cutthroat historically were present in this stream, the combination of habitat fragmentation (i.e. diversions, culverts, etc.), habitat disturbances (timber harvest, etc.) likely contributed to their extirpation (Barndt et. al. 2000).

The biological integrity, restoration potential, and educational outreach opportunities (because of their proximity to the refuge office) increase the value of this stream. If any parts of the upper watershed are privately owned salmonid management of this stream should include discussions with managers of upstream lands to encourage sound ecosystem practices such as selective cutting and riparian buffer strips (Barndt et. al. 2000).

Long Beach Watershed

Salmon are not present in significant numbers in this area due to lack of habitat and access. Many of the drainages from the Long Beach Peninsula have tide gates that block access for salmonids. Additionally, water temperatures often exceed those tolerated by salmon (Barndt et. al. 2000). No studies on this area have been completed to date.

5.0 Review and Funding Process for Pacific County WRIA 24

5.1 Overview

This chapter contains the administrative requirements, forms, flowcharts and other information pertinent to salmon recovery funding in Pacific County. The purpose of this chapter is twofold. First, it contains the required regulatory information to enact the salmon recovery plan in Pacific County. Second, it serves as a roadmap for potential applicants to work through the process to produce a viable project proposal. The players and their respective roles and the agreements that bind them together are defined in this section. The process for submitting a proposal and elements that it must contain are described to assist with project planning and proposal development. Lastly, a description of how the potential projects are to evaluated and by whom is provided to guide Pacific County with understanding the salmon recovery process.

5.2 Regulatory Framework

5.2.1 Salmon Recovery Funding Board (SRFB)

The Salmon Recovery Funding Board (SRFB) was established in 1999 by the Washington State Legislature. Their mission is to support salmon recovery by funding habitat protection and restoration projects, and related programs and activities that produce sustainable and measurable benefits for fish and their habitat. They are authorized to guide the spending of funds targeted for salmon recovery activities and projects.

The primary role of the Board is to fund the best salmon habitat projects and activities reflecting local priorities and using the best available science. The Legislature provides the overall authority, policy direction and budget for the Board to conduct its responsibilities. The Board is responsible for design and oversight of the funding process, ensuring the best results are produced and making adjustments when necessary.

Success in achieving the mission of the Board requires important partnerships with the Legislature, Governor, state and federal agencies, tribes and local communities throughout the state. Under the legislation (RCW 77.85) the Board's relationship with local communities is set forth through the creation of watershed-based lead entity organizations.

5.2.2 Lead Entities

Within the Salmon Recovery organizational matrix, lead entities are below the SRFB and above the Technical Advisory Group. Lead entities are essential in ensuring the best projects are proposed to the Board for funding in its annual grant process. In Pacific County, the Willapa Bay Lead Entity is supported by funding from the SRFB and WDFW. The Willapa Bay Fisheries Enhancement Group facilitates the Lead Entity process under the direction of the Willapa Bay Water Resources Coordinating Council (WBWRCC) acting as the Citizens Committee.

All lead entities have a set of technical experts that assist in development of strategies, and identification and prioritization of projects. The lead entity citizen committee is responsible under state law for developing the final prioritized project list and submitting it to the SRFB for funding consideration. Lead entity technical experts and citizen committees perform important unique and complementary roles. Local technical experts are often the most knowledgeable about watershed, habitat and fish conditions. Their expertise is invaluable to ensure priorities and projects are based on ecological conditions and processes. They also can be the best judges of the technical merits and certainty of project technical success.

Citizen committees are critical to ensure that priorities and projects have the necessary community support for success. They are often the best judges of current levels of community interests in salmon recovery and how to increase community support over time with the implementation of habitat projects. The complementary roles of both lead entity technical experts and citizen committees is essential to ensure the best projects are proposed for salmon recovery and that the projects will increase the technical and community support for an expanded and ever increasing effectiveness of lead entities at the local and regional level.

The SRFB will work to support the effectiveness of lead entities and the complementary roles of local technical experts and citizen committees. It will support the WDFW administration of the lead entity administration grants with the guidance, flexibility and support necessary for lead entity effectiveness. The SRFB will help inform the Legislature and Governor of the importance of lead entities and advocate for sufficient funding to carry out an increasing level of responsibilities and expanding effort in salmon recovery. The Board will encourage lead entity comments on its funding process and overall strategy to ensure the greatest effectiveness and efficiency. It will also sponsor programs that help develop the necessary skills and resources essential for lead entity success.

Lead entities that are in the early stages of assessing their watersheds and developing strategies should focus on projects that protect important habitats, eliminate blockages to functional habitats and increase the understand of local habitat conditions and processes. The projects should address the main limiting factors of the watershed as identified in limiting factors analysis. As lead entities increase their knowledge of watershed conditions and processes, complex restoration projects will be required to increase the productivity and abundance of habitat to meet recovery goals. (SFRB Funding Strategy 5/17/01)

The final prioritization of the projects will be conducted by the WBWRCC. Each member will score the projects taking into account primarily salmon benefits, and including additional considerations related to social, economic, technical, management, and public support. The combined scores for each project will be used to establish relative rankings of the projects.

5.2.3 Technical Advisory Group (TAG)

The purpose of the TAG is to work together as a group to review proposals in WRIA 24 and to assist the sponsor to improve projects for habitat restoration. The TAG will evaluate the screened projects to assess their degree of integration with other previous or current projects in the same watershed. The primary goal of the TAG evaluation will be to ensure that restoration projects have been conceived within a watershed-level context, and are part of a holistic method to restore habitat functions.

The TAG will assure that the proposed projects address the limiting factors for salmon and clearly benefit salmon. To this end, the TAG will be evaluating projects and conditions discussed in this process. This document will discuss all of these conditions to assist the TAG members to come to a final ranking. This ranking is not finalized but a guideline for the WBWRCC. The TAG will make recommendations to the WBWRCC regarding the relative benefit to salmon of each evaluated project. The TAG will pass all projects to the WBWRCC and follow the approved guidelines. The TAG will identify those projects that have met the necessary and sufficient/critical conditions for salmon recovery in WRIA 24, and rank those projects. The TAG will also identify those projects that failed to meet the necessary and sufficient/critical conditions, but these will not be ranked.

5.2.4 TAG and WBWRCC Ground Rules

Formal agreements are in place between the TAG and the WBWRCC. These are called the 'ground rules' and they have been approved and sanctioned by the Pacific County Board of Commissioners. These rules are included here in their entirety. The Willapa Bay Water Resource Coordinating Council (WBWRCC) and the Technical Advisory Group (TAG) receive competitive proposals annually from sponsors in WRIA 24.

In order to assure all sponsors are treated fair, the following ground rules will be followed.

1. Proposals must be submitted in accordance with the schedule established by the Pacific County Commissioners for each SRFB funding round. Proposals not received by the County by the dates established will not be considered for that phase of the review cycle or the funding period. The project list form must be completed prior to or as a part of the proposal submittal.

2. The proposals are considered proprietary; they are for use by the TAG and WBWRCC. They cannot be given to a third party for any reason without the written approval of the sponsor. Material and data in the proposals that was uniquely developed by the sponsor cannot be used by anyone without written approval of the sponsor.

3. Prioritization established by the WBWRCC is very important in getting projects funded. The sponsor will advise the TAG and WBWRCC if alternate funding is being requested. If alternate funding is obtained from another source, the sponsor will notify the lead entity immediately.

4. WBWRCC will not endorse, recommend, or support in any manner any projects or proposals that are not processed through the TAG and Prioritization process.

5. The TAG may have members who are submitting proposals; they are not required to abstain from voting on their projects. However, TAG members will review all TAG members voting and the TAG members can challenge any vote. WBWRCC members will not abstain from voting on projects that are submitted by any organization from which they may belong, or they have a personal interest. They will share their voting record with other members and support there position. Other members can challenge any vote that appears out of line.

6. The TAG will submit to the WBWRCC a ranking of projects with a score of 0-80, which relate to salmon benefits only. This ranking is guidance only. The WBWRCC will make the final determination as to the final prioritization.

7. WBWRCC members will submit their ranking of each project derived from the approved prioritization forms to the County for tabulation. The County will tabulate the results and report the results to the WBWRCC for further consideration prior to final approval.

8. The TAG will not have the authority to reject any proposal for any reasons. Proposals referred to WBWRCC by the TAG will have a ranking of 0-80. This score is based upon the TAG's evaluation of the technical merits of the project and its ability to meet the SRFB requirements for funding. The TAG's job is to assist sponsors in submitting acceptable projects that will meet the SRFB criteria. The WBWRCC has the authority to reject proposals for cause, but must relate the cause directly to SRFB criteria.

9. After the final draft submittal of the proposals, some minor changes to the projects are allowed. However, after the initial WBWRCC prioritization, the scope and budget for the project cannot change.

10. Projects submitted for consideration must address limiting factors, watershed analysis, or other supporting data based upon on actual on site survey and technical data.

11. The WBWRCC and the TAG meeting are open to the public. They are not "public hearings", and the Chair will control input by non-members. Voting is limited to members only

12. Each voting member will rank each project 0-80, which will be given to the Chair for tabulation. The final ranking will be determined by simple average of all scores of the members. There will be no minimum membership quorum requirement.

5.3 Project Application Process

5.3.1 Project Identification

The sponsor or applicant will select a project from the Salmon Habitat Restoration Projects Database Form, that has no sponsor, or prepare a new project by completing the Salmon Habitat Restoration Projects Database Form (Figure 3). Information on potential projects will be compiled and included in a computer database. The information collected will include project type, location, landowner, budget, monitoring plan, limiting factors addressed, salmon species affected, and any other information deemed necessary. This will be submitted to Pacific County prior to the proposal due date. The flow diagram on page 58 shows the general flow of the entire process. The document will discuss each section and how the TAG will evaluate proposals at each stage.

The following is a list of suggestions for a sponsor or applicant to consider when starting a project.

- Read the Pacific County (WRIA 24) Strategic Salmon Recovery Plan.
- Read a Vision for the Recovery of Willapa Salmon (Willapa Alliance 1998) and explore some opportunities to get involved with a project.
- Talk to knowledgeable people about your ideas and get input.
- Research potential areas for habitat improvement projects. Again this Strategic Plan will help guide you.

- Develop collaborative approaches wherever possible. This will not only spread the work but provide opportunities to learn more, produce a greater benefit for fish and have more fun.
- Contact all the landowners associated with your project. This needs to be done to gain prior approval to work on their property. You are likely to gain their support if you approach them in a friendly, open and informed manner.
- Whenever you work in streams or get involved with fish enhancement project, you need to get approval and in many cases permits from various state or local agencies such as the Washington Department of Fish and Wildlife and Pacific County. Contact a department representative long before you intend to start the project.
- Develop a plan and time schedule for your project with specific milestones and dates to insure that activities are accomplished in the appropriate order and during the right time of year. This helps ensure that the entire project gets completed on schedule.
- Keep complete and accurate records of the people you contact and the work that you do. This will be a component of the required monitoring report. You will need them later to share with others, especially lessons learned.
- When the project is over, make sure you have communicated with all the partners involved, such as state and local agencies, landowners, and volunteers.

Project Development and Selection

Projects can be assigned immediate, intermediate or long-term priorities based upon their position in the screening and selection process. The critical nature of a project is assessed based upon the following criteria that are tied to the guiding principles and the key issues (limiting factors) identified within WRIA 24. Some of the proposal screening criteria address a single key issue, others encompass multiple issues. Much of the impact criteria described below is taken from the *Limiting Factors* analysis (Smith 1999). These screening criteria are general in nature. They are to be treated as guidelines and not absolute methodologies to be followed. Other assessments of the particular key issues are not prohibited from use. The goal of the assessment is to develop a value rating upon which the TAG and WBWRCC can evaluate potential projects.

Fish Blockage
The Washington State Conservation Commission (Smith 1999) prepared an impact rating for blockage of fish habitat in Pacific County (WRIA 24). Habitat blockage may result from road construction, culverts, or tidegates. The general impact of these blockages in measured in terms of how much upstream habitat is removed from use. The lost habitat is commonly measured in miles of stream length with the larger the length of lost habitat, the greater the impact of the particular blockage. The following table provides one measurable assessment for evaluation when considering habitat restoration projects.

Blockage Impact Rating:	
Low	**<0.25 miles habitat blocked**
Medium	0.25 – 0.99 miles habitat blocked
High	> 1.0 miles habitat blocked

Large Woody Debris (LWD)
Similarly, the Washington State Conservation Commission (Smith 1999) prepared an impact rating for loss of large woody debris on fish habitat in Pacific County (WRIA 24). Loss of LWD from riparian forests alters fish habitat characteristics such as pool spacing, pool area, and pool depth (Montgomery et al. 1995, Beechie and Sibley 1997, Abbe and Montgomery 1996), and this

alteration of habitat characteristics results in changes in the salmonid carrying capacity of a stream (Hicks et al. 1991). LWD condition is measured in terms of the amount of LWD present in the stream channel relative to the channel width. LWD is also described by the relative importance it plays in a stream. A "key piece" of LWD is one that is critically integrated into the stream channel and defines the channel character. A "functional piece" of LWD is one that is not an integral part of the stream channel yet plays a more transient role in fish habitat. Functional pieces of LWD are mobile and will shift with high flows until they become imbedded into the stream channel. At that time, they become key pieces. The number of key and functioning pieces of LWD per channel width of stream determine the level of habitat function. General LWD abundance criteria are listed below.

Loss of Large Woody Debris (>1.0′ diameter) Rating	
Poor	<1 piece/channel width
Properly Functioning	0.5 key piece/stream width + 2.0 functional key pieces/stream width

Riparian Condition

The Washington State Conservation Commission (Smith 1999) has stated that poor riparian condition is a key issue in Pacific County (WRIA 24). Other strategic plans have assessed the functionality of riparian condition. Riparian forest buffers of 40 meters or more (each side of the stream) are capable of producing 80% or more of the potential late-seral LWD recruitment (Skagit Watershed Council 1998). Streams with forested buffers greater than 40 meters wide are considered "functioning" habitat for LWD recruitment. When the riparian forest can produce 50% to 80% of the potential late-seral recruitment (i.e., buffer width between 20 and 40 meters), riparian functions are considered to be "moderately impaired". At buffer widths less than 20 meters, riparian functions are considered "impaired" (Skagit Watershed Council 1998, Forest Ecosystem Management Assessment Team 1993). General rating criteria for riparian condition is presented below.

Rating of Riparian Condition	
Impaired	<20 meters of riparian width
Moderately Impaired	Between 20 and 40 meters of riparian width
Functioning	>40 meters of riparian width

Canopy cover is an easy to measure but critical element in assessing riparian condition. Canopy cover is important for moderating instream water temperature. Shade plays a major role in maintaining summer temperature regimes within proper physiological ranges for salmonids. Algal growth is also tied to canopy cover (USDA, NRCS 1999). Direct exposure of the stream channel to sunlight increases temperatures and promotes algal growth. Excessive algal growth and temperature results in macroinvertebrate population shifts, stream productivity decreases and reduced salmonid support capacity. The following table can be used in concert with the previous table on riparian width to more fully evaluate riparian conditions associated with proposed projects. .

Canopy Cover Rating	
Good	> 75% of water surface shaded and upstream 2 to3 miles generally well shaded

Adequate	> 50% shaded in reach or > 75% in reach but upstream 2 to 3 miles poorly shaded
Fair	20 – 50% shaded
Poor	< 20% of water in reach shaded

Sedimentation

Input of sediment into streams is a natural process and required for proper stream health. However, excessive sediment loading leads to reductions in spawning habitat quality, water quality conditions and rearing habitat quality. Where sediment supply is less than 100 $m^3/km^2/yr$, the habitat in all downstream reaches is considered to be "functioning" with respect sediment supply. Where sediment supply exceeds 100 $m^3/km^2/yr$, downstream habitats are considered to be "impaired" with respect to sediment supply (Skagit Watershed Council 1998).

Sediment Supply Rating	
Impaired	> 100 $m^3/km^2/yr$
Functioning	< 100 $m^3/km^2/yr$

Spawning Gravel

Loss of spawning gravel has been cited as one of the key issues within WRIA 24 (Smith 1999). Spawning gravel condition is closely linked to sedimentation and the criteria below should be evaluated in light of the sedimentation criteria listed above. There are a number of methods to estimate the quality of spawning habitat. The following table presents just one method (WDFW 1998). Other methods are also viable. The goal of quantifying spawning habitat is to determine if this limiting factor can be offset by the proposed project.

Habitat Condition	Rearing Habitat Criteria	Spawning Habitat Criteria
Good to Excellent	Rearing Habitat is stable and in a normal productive state with all components functional	Spawning gravel patches have <16% fine particle sizes that are <0.85mm in diameter
Fair	Rearing habitat shows moderate/widespread signs of instability and/or disturbance known to reduce productive capability (one or more habitat components missing or significantly reduced presence)	Spawning gravel patches/riffles show moderate/widespread signs of instability (scour/filling) and/or >16% and <21% fine particle sizes 0.85 mm in diameter.
Poor	Rearing habitat shows signs of major/widespread disturbance likely to cause major reductions in its productive capabilities (two or more habitat components missing or significantly reduced presence)	Spawning gravel patches/riffles show major/widespread signs of instability (scour/filling) and/or >21% and <26% fine particle sizes 0.85 mm in diameter.
No Value	Rearing habitat severely disturbed so that production capabilities are with out value to salmonids at this time.	Spawning gravel patches with >26% fine particle sizes 0.85 mm in diameter.

Estuarine Habitat
Estuarine habitat has been lost within the Willapa Basin. The loss of LWD in the estuary and the increase in *Spartina* are the primary causes of reduced estuarine habitat. Numerically evaluating these two agents is subjective at this point and more research in underway on both. For projects proposed in estuarine areas, a description of percent cover of *Spartina* will be necessary. Evaluation of LWD should focus on size, type and location of wood within the project area relative to the proximity of freshwater inputs and salmonid producing streams.

Project Completion – Monitoring and Maintenance

General Approach

The WBWRCC will not support restoration or protection projects without a "reasonable" monitoring and maintenance plan. Each monitoring plan should be linked to the WBWRCC's overall habitat protection and restoration strategy to ensure "feedback" for adaptive management. The WBWRCC employs the three monitoring types: implementation, effectiveness, and validation. The Skagit Watershed Council has prepared much of the information contained in this monitoring and maintenance section.

Implementation monitoring

The first step of project monitoring involves careful review of the construction and restoration activities associated with each project. Implementation monitoring will generally be required for all projects. Implementation monitoring answers the question: Were the identified project activities correctly carried out on the ground? This will primarily be accomplished through photographic methods, before and after the corrective action has taken place.

Effectiveness monitoring

Effectiveness monitoring is used to determine if the project's objectives were achieved by what was done on the ground. Each table found in the next section provides general guidelines and techniques to be used by the project proponent to develop an effectiveness monitoring plan. It is important that the proposed monitoring approach be testable and measurable. Annual photographic monitoring will also occur for a timeframe agreed upon by the WBWRCC and the project proponent.

Validation monitoring

Validation monitoring is the third and final monitoring phase. Validation monitoring evaluates if the hypothesized cause and effect relationship between the action and habitat conditions or ecosystem function were correct. For example, in a sediment reduction project, validation monitoring would determine whether reduced sediment supply actual restores channel morphology and pool depths as expected. Validation monitoring is part of each project plan

Database Management

Originals of all monitoring forms and videotapes will be maintained by the project proponent. Copies of all monitoring forms will be forwarded on to the WBWRCC for their inclusion and tracking in a centralized location. A number of databases currently exist: the historic project list, the culvert assessment sorted by road, and another blockage assessment sorted by blockage type.

Guidelines For Monitoring And Maintenance Plans By Project Type

The following tables include a listing of general habitat protection or restoration project action categories. Each action category contains a list of the following elements:

- typical objectives,
- statements of problems and solutions,
- implementation and effectiveness monitoring guidelines and monitoring techniques,
- maintenance plan recommendations.

The following tables can be used by a project proponent to formulate a project specific monitoring and maintenance plan. Each table contains general monitoring guidelines for each project category. Some projects may require a more rigorous or comprehensive effectiveness monitoring program depending on the scale and complexity of the project. Over time, it is likely that additional tables will be added to accommodate projects that may not fit into the existing category types.

Fish Passage Project

Objective: Remove fish barriers that causes an excessive delay and /or abnormal expenditure of energy during the movement of fish in the basin.

Problem

Culverts : High velocity within culvert exceeds swimming ability of juvenile and or adult salmon. Excessive drop at culvert outlet limiting juvenile and or adult fish entry into the culvert. Inadequate depth within culvert (sheet flow) limiting adult and or juvenile fish passage through culvert. High velocity and or turbulence at culvert inlet and or outlet creating standing wave conditions which limit passage.
Dams and/ or spillway : Creates velocity, sheet flow or height barriers to free passage of juvenile and or adult fish into impoundment.
Off channel rearing habitat isolated due to fill, diking, channel change
Tide gates restrict free movement of juvenile and adult fish into estuary and slough habitats.

Examples of Specific Actions

Remove culvert or reduce height of jump by lowering culvert, installing downstream controls weirs. Remove culvert or replace with larger cross section culvert or span creek with bridge. Remove culvert or increase water depth in culvert by embedding in stream bed, reducing culvert slope, installing baffles, installing control weirs downstream of culvert. Remove culvert or change entry and exit conditions, increase culvert cross section. Remove dam or provide fish ladder that meets WDFW fish passage requirements. Remove or modify tide gates or dikes to reconnect isolated habitat.

Monitoring

Implementation: Verify that the project was built as designed.	Effectiveness: Is the project passing fish upstream
Complete an as built drawing of the project. Measure such physical parameters as stream flows, water depths, water velocity, and height of steps that fish must jump.	Are any of the measured as built physical parameters beyond the fish passage limitations of the target species and life stage.
Discuss any variation between as built and designed project.	Document adult fish or redds upstream of culvert in fall and winter. To document juvenile passage, observe juvenile fish moving upstream through the facility at likely migration periods.

Maintenance Plan

1. Describe the maintenance plan for the life of project. What party will be responsible for routine inspection and or maintenance of structure. How often will the site be visited. Is there funding available to carry out the plan?

Riparian Restoration Project

Objective: Implement activities that will speed the recovery of riparian functions

Problem

Riparian corridors along many lowland and forest streams have been altered by land use practices (urbanization, farming, grazing, drainage district maintenance, logging) upsetting natural landscape processes which benefit fish populations. Stream side vegetation provides canopy shade to cool water, stream bank roughness to slow flows and disperse energy, root structure to strengthen stream banks, LWD for fish cover, detritus and carcass retention for nutrient sources.

Example of Specific Action

Install and maintain stream side fencing
Interplant appropriate conifer species
Plant disturbed riparian area (e.g. grazed area, skid trails, landings, hot burned stream side area
Plant on flood deposits (high bars) near channels
Thin hardwoods to allow for conifer release.

Monitoring

Implementation: Verify that the project was planted / fenced as designed.	Effectiveness: Are the plants growing and being maintained to insure establishment of an effective riparian corridor?
Briefly describe site conditions, dominant vegetation types prior to project, average width of riparian buffer, and any site preparation work performed. Estimate number of plants of each species and size planted, and any other treatments applied to improve survival.	What percent of the plant material survived the first summer; the second summer. Has the species mix significantly changed. What do you determine to be the major cause of plant mortality (rodent damage, reed grass competition, beaver, etc. Based on the observed plant growth how many years will be required for plants to reach 30% of mature stand height.
Briefly describe any fencing completed, land owner agreements, conditions, setbacks. Discuss any variation between as-built and designed project.	Is the fence effectively excluding livestock from the riparian corridor for the term of the agreement or life of the project. What happens at end of agreement or life of fence.

Maintenance Plan

Describe the maintenance plan for the first five years of the project. What party will be responsible for routine inspection and or maintenance of the site. How often will the site be visited. Is there funding available to carry out the plan. Is funding available to replace dead plant material.

Road Sediment Reduction Projects

Objective: Implement activities which reduce forest road related sediment from mass wasting and surface erosion sources to improve natural stream channel process and function.

Problem

Course sediment from mass wasting events (landslides) negatively impacts stream bed load and channel morphology. Effects are more apparent in lower gradient sections of the channel (response reaches). Large increases in course sediment supply tend to fill pools, widen and aggrade channels.
Large increases in total sediment supply to a channel also tend to increase the fine sediments in the bed which may impact the survival of incubating eggs.

Examples of Specific Action

Storm proof and upgrade forest roads, reroute road drainage to stable receiving area, correct concentrated road drainage, correct stream diversion potential at stream crossings, revegetate bare cuts and fills, remove or reconfigure unstable fills, upgrade stream crossing to pass 100 year flow events.
Decommission roads: De-compact road surfaces, seed, remove road culverts, out slope and water-bar road surfaces, remove unstable fill and side casting.

Monitoring

Implementation: Verify that the project was constructed as designed.	Effectiveness: Is the completed project accomplishing the desired reduction in sediment supply.
Briefly describe the project as built, miles of road de-commissioned, surfaces treated, culvert removed, etc. . How does the finished project differ from the design?	Aerial photo landslide inventories and field surveys in future years to determine if work reduced sediment supply. (See Beamer et al. 1998)

Maintenance Plan

Describe the maintenance plan for the first five years of the project. What party will be responsible for routine inspection and or maintenance of the site. How often will the site be visited. Is there funding available to carry out the plan.

In Channel Projects

Objective: Implement activities that improve natural stream channel process and function.

Problem

Stream channel has been realigned, simplified, ditched, diked, constricted. Channel has lost natural meander pattern, pool rifle complexity, ability to sort or transport gravel.
Bank protection projects using rock rip rap simplify channel complexity, reduce energy dissipation.

Examples of Specific Actions

Allow channel to return to natural meander, assist by selective excavation or placement of LWD or rock deflectors. Remove constrictions. Set dike back to allow for natural floodplain processes. Limit the use of rock to protect toes of banks, construction of deflectors. Use more creative bioengineering approaches to bank stabilization.

Monitoring

Implementation: Verify that the project was constructed as designed.	Effectiveness: Is the completed project accomplishing the objective.
Briefly describe the project as built. How does the finished project differ from the design. What factors help in project implementation, which factors hindered implementation. What would you do different.	Photo point documentation. Completed project, year 1,2,3.
Establish before and after photo points to document channel changes.	

Maintenance Plan

Describe the maintenance plan for the first five years of the project. What party will be responsible for routine inspection and or maintenance of the site. What party assumes responsibility for damage to property resulting from channel work. How often will the site be visited. Is there funding available to carry out the plan. Is funding available to replace failed structures, rock, LWD.

Habitat Protection Projects

Objective: Protect important stream reaches, riparian areas, wetlands, and upland buffers from land clearing activities, development, livestock grazing and other potential encroachments through acquisition of fee-title or less-than fee interest.

Problem

High quality riparian and wetland habitat is threatened by modifications caused by land use activities including: clearing of vegetation buffers; livestock grazing; dredging, filling; diking and channelization; and development.
Degraded riparian and wetland habitat targeted for restoration often lack long-term protection from changes in landowner's objectives or management priorities for their property. This may threaten the viability of the restoration project.

Examples of Specific Actions

Acquire conservation easements or fee title on key riparian areas and wetlands: from willing sellers or donors, purchase or solicit donations of property rights necessary to ensure the long-term integrity of the natural processes. This may include acquisition of timber, farm/grazing, development rights, and/or restriction on hydrological modifications.

Monitoring

Implementation: Verify that necessary transactions have occurred, and legal documents are recorded.	Effectiveness: Will the actions taken provide for the long-term protection of the identified habitat conditions or natural landscape processes?
Are necessary easement and/or conveyance documents recorded with County Auditor? Is the landowner aware of the restrictions placed on the property and his or her management responsibility? Need for property survey????	Is easement or title held by a qualifying conservation organization or government entity? Are the land use restrictions adequate to protect habitat and natural landscape processes? Does the document conform to national standards for conservation easements? Does the entity holding fee or title have sufficient resources to maintain and/or monitor the property, and enforce compliance?

Stewardship/Compliance Monitoring

Describe the compliance monitoring plan for this property. What party will be responsible for routine inspection of the site? How often will the site be visited? Is there funding available to carry out the plan and enforce compliance if necessary?
For acquisition of land in fee, describe what resources the organization has available for stewardship planning and management activities.
Have any biological inventories or maps been prepared? Need for baseline inventory and mapping for future monitoring purposes. Inventories and maps should focus on the resource values for which the property is being protected.

Hydrology (and floodplain)				
Project Type	**Secondary Obj.**	**Monitoring Questions and approaches**	**Maintenance planning**	**Sources**
Tidal hydrology: Tide gate removal or alternative gate management	Restore original tidal flow patterns; restore tidal area vegetation	Monitor water flows at high and low tides along the entire affected area. Measure salinity. Monitor vegetation establishment within tidal area	If native vegetation do not establish; reintroduce tidal vegetation. Remove non-native plants	Mitsch & Gosselink 1993; Mitsch 1994
Tidal hydrology: Dike removal/set back/breaching	Restore original tidal flow patterns leading to flood plain dynamics; restore tidal area vegetation	Monitor water flows at high and low tides along the entire affected area. Measure salinity. Monitor vegetation establishment within tidal area	If native vegetation do not establish; reintroduce tidal vegetation. Remove non-native plants	Mitsch & Gosselink 1993; Mitsch 1994

Water Quality				
Project Type	**Secondary Obj.**	**Monitoring Questions and approaches**	**Maintenance planning**	**Sources**
Water Quality Projects: Non-point source reduction projects	Reduce effects of eutrofication or sediments.	Bioassessment of nutrient reduction. Monitoring of total suspended sediment		Chapman 1996
Water Quality Projects: Composting Dairy Waste (reduction), and other nutrient loading reductions such as septic.	Reduce effects of eutrophication within stream reach. Reduce pollutant inputs to stream	Select appropriate bioassessment method to monitor changes over time. Preferably macroinvertebrates. Coliform counts reduced		Karr & Chu 1997; Chapman 1996
Water Quality Projects: Stormwater	Reduce pollutant inputs from storm water runoff. Restore hydrograph.	Monitor hydrograph. Non-urban areas: monitoring should include a bioassessment method. Urban areas: measure micropollutants in runoff water.		Azous & Horner 1997; EPA ; WADOE;

		Measure sediment reduction.		

5.3.2 Salmon Habitat Restoration Projects Database Form

The sponsor will complete the Salmon Habitat Restoration Projects Database Form (Figure 3). Its' primary purpose is to ensure salmon habitat project proposals are appropriate within each watershed and sequenced in a logical manner. The project applications will undergo a rigorous screening process to identify projects that address the limiting factors within the subject watershed. Project proposals must include a project discussion that justifies the project in relation to the known limiting factors for the subject watershed or basin. Additional scientific studies should also be referenced to further justify and explain the merits of the proposal to restore, enhance or protect salmonid habitat.

Some of the key elements of the habitat work schedule are:

- Identify and coordinate with other projects
- Identify potential projects
- Develop budget timelines
- Show affected salmonid species
- Identify limiting factors
- Identify supporting scientific literature
- SRFB Guidelines

There are eleven necessary elements of the Salmon Habitat Restoration Projects Database Form (Figure 3) that must be completed for the project to receive consideration by the WBWRCC. The sponsor will submit the completed form to the County. The following page presents a flow chart describing the project identification process.

Figure 3. Salmon Habitat Restoration Projects Database Form

Please return to: Willapa Bay Fisheries Enhancement Group, P.O. Box 046, South Bend WA 98586. 360 875 6402, FAX 360 875 5802

Project Name:	Project Type:	Township, Range, Section:
Watershed:	Sub-Watershed:	Stream Reach:

Additional Location Information:
.

Limiting Factors Addressed (check all that apply):

( ) Fish Blockage	( ) Water Quality	( ) Streambed Sediment
( ) Floodplain Condition	( ) Water Quantity	( ) Estuarine Condition
( ) Riparian Condition		

Other Limiting Factors (please specify):.

Does project address the limiting factors listed in <u>Salmon and Steelhead Habitat Limiting Factors in the Willapa Basin</u>?

Salmonid Species Affected (check all that apply):

( ) Chum ( ) Chinook ( ) Coho ( ) Steelhead ( ) Cutthroat Trout

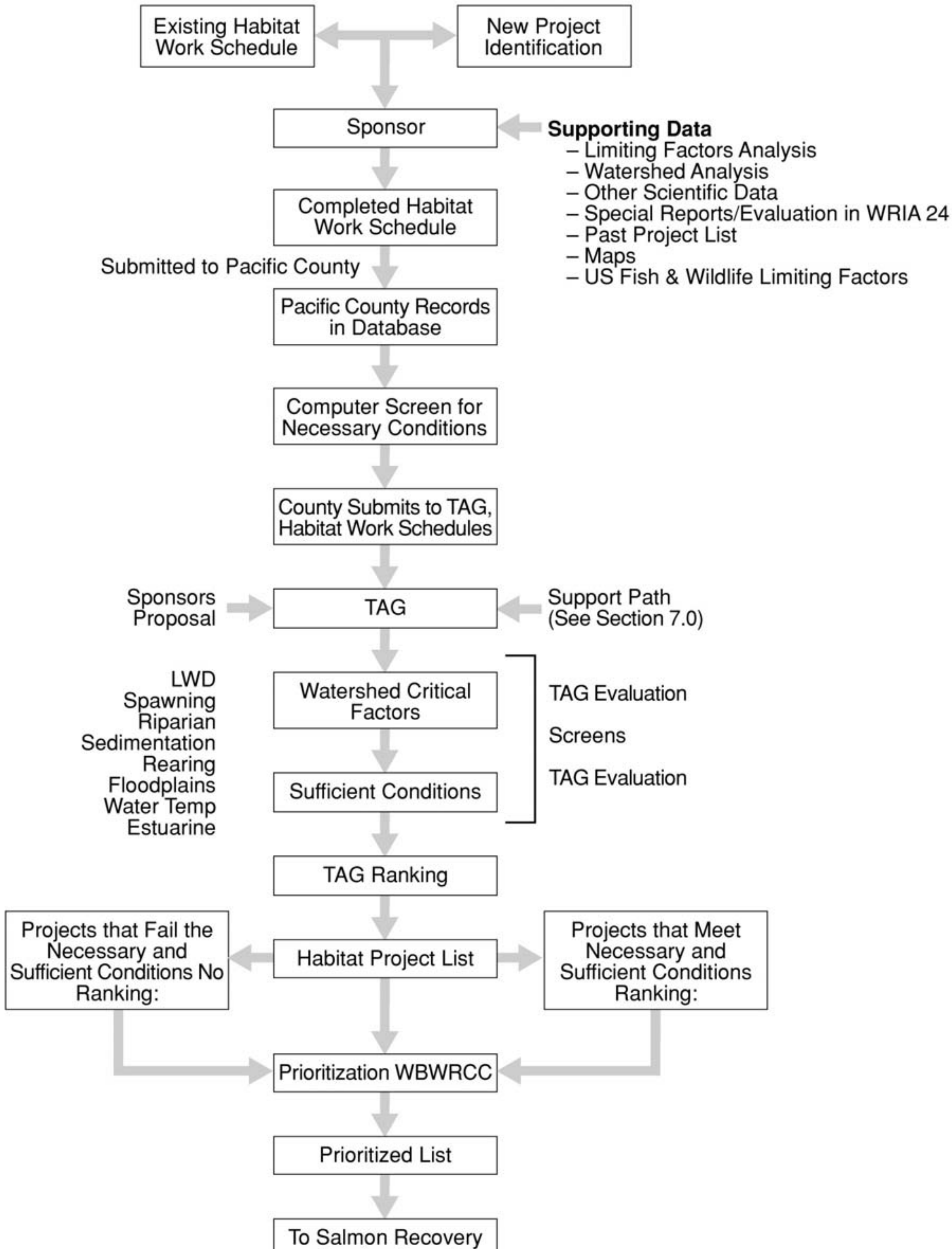
Other species (please specify):

Affected ESA listed species:	Affected SASSI listed species:
Amount of habitat restored:	Watershed Analysis Complete?

Landowner: Landowner permission granted?	Project sponsor:	Other project partners:
Project Budget:	Landowner matching funds:	Other matching funds:

Project Duration:	What permits are required for project completion? .
Is a monitoring proposed for this project? .	( ) Engineering design in hand? ( ) Planning ( ) All permits applied for? ( ) All permits in hand?

Project Identification Process Flow



993 1002.1201/10565.fh9

5.3.3 Screening/Data Entry for Salmon Habitat Restoration Projects Database Form

After receiving the form, the County will enter it into the Salmon Habitat Restoration Projects Database Form. The program will automatically evaluate the form and report those projects that meet the eleven necessary conditions (on the habitat work schedule). All projects submitted to the County for the funding round will be reported to the TAG, and will be identified as those projects that meet the eleven necessary conditions. All projects submitted to the County for the funding round will be reported to the TAG, and will be identified as those meeting and not meeting the necessary conditions.

TAG Review Process

The following steps are taken by the TAG when the County receives an application for funding. The TAG takes the submitted Salmon Habitat Restoration Projects Database Form and creates a Habitat Project List by using the Critical Path Methodology (CPM). This involves a careful review of the proposal contents and comparisons to pertinent data. Specifically, the TAG may employ the following data sources during their evaluation of proposals. Additional data sources may be requested of sponsors or gathered by the TAG as necessary.

- Limiting factors analysis
- State, regional, SRFB, and local criteria
- Relationship to past, present projects
- Identification of project sponsors
- Identification of willing landowners
- Recovery strategy
- Monitoring and evaluation plan
- Adaptive management strategy
- Agencies support

This also involves looking at the key issues and watershed sufficient conditions. The TAG should consider the key issues for each watershed. The TAG should evaluate the proposal for that watershed and be assured these critical conditions are addressed. These are summarized as limiting factors for the entire WRIA 24 in Section 4 of this document. In short, the key issues that each proposal must address, if appropriate are:

- Fish blockage
- Loss of LWD
- Poor riparian condition
- Sedimentation
- Loss of spawning gravel
- Loss of estuarine habitat
- Estuarine conditions

Each TAG member will evaluate and report an individual ranking of each proposed project. A compilation of all projects ranked individually by each member will be prepared and used to develop a master list of ranked projects. The product of this process is a project list that reflects the overall ranking of the TAG for funding priority. Each TAG member will report to the chair his/her ranking as a whole number 0-80. The Chair will take the average of all the members, which will become the ranking. This will be known as the "Habitat Project List". This will be forwarded to the WBWRCC for prioritization, and then the final Prioritized Habitat List will be forwarded to the SRFB, along with all the proposals for funding.

WBWRCC Review Process

The WBWRCC also has a project ranking form called the WBWRCC Prioritization Scoring Guideline (Figure 4). The TAG ranking of 0-80 (with some latitude for modification based upon the limiting factors analysis) is added to a Social/Economic/Environmental/Technical Management score. Total maximum points are 100. This becomes the final Prioritized Habitat List.

Table 4. The WBWRCC Prioritization Scoring Guideline.

Item	**Scoring Range**	
Benefits to Salmon (Based upon Limiting Factors Analysis, TAG Input)	0 – 80	_____
Social/Economic/Environment/Technical Management (10 items)	± 20	_____
Total points (Report Total to Lead Entity)		_____ (100 Max)

Scoring Guideline ± 20

1) Evaluate Sponsor - Management Approach/Track Record
2) Evaluate Pre-Engineering/Planning Completed
3) Evaluate Impact on Roads, Utilities, Access, Land Use, Flood Hazard, and Water Use
4) Evaluate Project Impact on Public Use of the Project Area and Changes as a Result of Project
5) Evaluate Non-Salmon Ecosystem Effects on Wildlife Habitat Resources
6) Evaluate External Risks to Project, i.e., Planned Road Construction, Land Use in the Area of the Project, etc.
7) Evaluate the Public Support and Opinion of the Project?
8) Evaluate the Impact of the Project on Local Economy in Terms of Job, Tax Base. Look at Both Short Term and Long Term
9) Evaluate the Public Outreach/Education by Involving the Public in Salmon Restoration
10) Evaluate the Impact of the Project to the Quality of Life Around the Project

NOTE: These are guidelines only to assure all WBWRCC members are focused on the same issues. Your evaluation is your own; there are no right or wrong scores.

SRFB Review Process
The final Prioritized Habitat List with the addition of the Lead Entity application is submitted to the SFRB for funding consideration. For the 2001 funding cycle the SRFB has put together a list of funding policies (SRFB 2001). They are included here in their entirety to help project applicants and sponsors focus their proposals to the areas considered most important this year by the SFRB.

1. **Fish and Habitat Benefits.** Projects are prioritized based on the anticipated benefits to salmon, the certainty that the project will be successful in providing those benefits, and the project's cost relative to the anticipated benefits.

   Benefits. How the list of projects benefits naturally reproducing salmon and the ecosystem functions on which they depend.

   Certainty. The certainty that a project will be successful in providing anticipated benefits. This includes:

   - the level of certainty that prioritized projects address the important known limiting factors and in the right location and sequence;
   - certainty that the type and design of the project ensures it has a high probability of success in realizing its anticipated benefits; and
   - community support or opposition that might affect the success of a project.

   Cost. The SRFB recognizes that currently there is no methodology for determining benefit-to-cost ratios for habitat projects. However:

   - Projects should have a reasonable cost relative to the anticipated benefits. There may be more cost-effective ways of addressing the same limiting factor through alternate project sites, types and designs.
   - Projects should be designed to address the project goals in the most cost-effective manner. This could include design features, materials, and use of donated materials and labor.

2. **ESA Listed Fish.** Actions that support species of fish listed under the Endangered Species Act and the health of their habitats should receive preference in funding decisions.

3. **Naturally Spawning Fish.** Watersheds and river systems with naturally spawning populations shall receive preference over systems dominated by hatchery stocks.

4. **Protection of Intact Habitat.** Protection of areas with intact habitat processes and high quality habitat, especially where they are threatened by imminent harm, should be a priority.

   Most scientists agree that, while habitat protection alone is not sufficient to recover salmon, it is crucial that we protect our remaining base of functional habitat and build on this base with restoration actions. It is far cheaper to protect threatened habitat today than to restore it tomorrow. The Board recognizes, however, that habitat restoration will also be necessary to achieve salmon recovery and that lead entity habitat recovery strategies may justifiably place a priority on restoration.

5. **Habitat Restoration.** Projects should be aimed at restoring natural habitat-forming processes in addition to addressing degraded conditions.

   Addressing a specific habitat condition, such as the lack of spawning gravel or woody debris, may lead to short-term improvements but may not be successful in the long-term because it does not address habitat-forming process such as gravel transport and LWD recruitment. It is preferable that projects help restore natural functions rather than only addressing symptoms resulting from disturbance of these functions. Proposals to restore poorly functioning habitat should complement the protection of existing high quality habitat in a watershed.

6. **Experimental Projects.** By their very nature, these types of projects may have a low certainty of success. However, the Board will fund experimental projects if the information resulting from the project will benefit salmon recovery in the long run. Projects must include a monitoring plan that will adequately assess their success.

7. **Assessments.** The Board recognizes that watershed-wide assessments such as limiting factors analysis do not always provide information sufficient to identify the most effective site and sequencing of projects. The Board will fund targeted assessments and feasibility studies as long as they will directly lead to identification, siting, or design of habitat protection or restoration projects. Assessments intended for research purposes, monitoring, or to further general knowledge and understanding of watershed condition and function, although important, are not eligible.

8. **Projects With Prior Legal Obligation.** If a local, state or federal law already provides a legal obligation to perform the habitat restoration or protection work proposed by the project, the project must provide a clear benefit to salmon and the proponent must demonstrate there would be harm to salmon recovery if the project were not conducted immediately.

9. **Programs and Activities.** Programs and activities that are not site-specific or have a geographic scope greater than a single lead entity area may not readily fit in the lead entity project prioritization process. In the past, the Board has been asked by the Legislature, Governor, and program proponents to consider funding such activities. The Board is currently discussing the development of an approach for seeking and evaluating such funding requests.

5.4 Summary of Review and Funding Process

The review and funding process in Pacific County (WRIA 24) is expected to occur on an annual cycle. The SRFB annually establishes the funding cycle. The citizens group in Pacific County reviews the SRFB application requirements and schedule. Following review and consideration, the citizens group makes a recommendation to the County Commissioners for approval of a firm schedule and proposal focus. Following this, newspaper advertisements are published, applications are prepared and reviewed by the TAG and WBWRCC, and recommendations are made for funding to the SRFB.

6.2 **Page 67**

Naselle Matrix Showing Prioritized List of Potential Projects

Rank	Name of Project	Location	GPS	Land-owner	Project Type	Cost Estimate	PP#
#1	**Project #17** South Naselle River Riparian Restoration	South Naselle T10NR9WS33	46.18.324 123.47.981	Campbell Group	Riparian Restoration	$50,000-$100,000	16.01
#2	**Project #19** Tributary Restoration	Trib to South Naselle River T10NR9WS20	46.20.405 123.48.967	Campbell Group	Stream Restoration	$50,000-$100,000	13.66
#3	**Project #15** Salmon Creek Road Abandonment	Salmon Creek T11NR8WS13	46.25.728 123.36.942	Campbell Group	Road Abandonment & Restoration	$50,000-$100,000	13.01
#4	**Project #20** O'Conner Creek Log Jam	O'Conner Creek T11NR9WS34	46.23.461 123.46.932	Unknown	Passage Barrier Analysis	>$50,000	12.49
#5	**Project #18** Johnson Creek Stream & Pond Restoration	Johnson Creek T10NR9WS4	46.22.873 123.48.289	Unknown	Stream & Rearing Pond Restoration	$100,000-$500,000	11.34
#6	**Project #14** Salmon Creek Invasive Removal	Salmon Creek T11NR8WS27	46.21.968 123.46.891	Unknown	Invasive Vegetation Removal	$100,000-$500,000	10.01

6.1 **Page 65**

Nemah Matrix Showing Prioritized List of Potential Projects

Rank	Name of Project	Location	GPS	Land-owner	Project Type	Cost Estimate	PP#
#1	**Project #23** North Nemah River Bank Stabilization	North Nemah T12NR9WS32	46.29.017 123.48.898	Weyer-haeuser	River Bank Restoration	$50,000-$100,000	15.84
#2	**Project #7** Mid-Nemah LWD Placement & Planting	Middle Nemah T11NR9WS9	46.27.260 123.48.163	WDNR	LWD Placement & Planting	$50,000-$100,000	15.34
#3	**Project #11** Finn Creek LWD Placement	Finn Creek T12NR10WS29 &30	46.29.658 123.49.115	Weyer-haeuser	LWD Placement	$100,000-$500,000	15.01
#4	**Project #4** Mid-Nemah Bridge Removal	Middle Nemah T11NR9WS6	46.28.207 123.50.076	WDNR	Bridge Removal	$50,000-$100,000	14.84
#5	**Project #5** Mid-Nemah Tributary Restoration	Middle Nemah T11NR9WS6	46.28.052 123.49.956	WDNR	Tributary Restoration	$100,000-$500,000	14.51

#6	**Project #3** Mid-Nemah LWD Placement	Middle Nemah T11NR9WS5, 6 &9	46.28.867 123.51.268	WDNR	LWD Placement	$100,000-$500,000	14.51
#7	**Project #6** Bridge Removal	Mid-Nemah T11NR9WS9	46.27.226 123.47.712	WDNR	Bridge Removal	$50,000-$100,000	14.34
#8	**Project #12** Finn Creek Riparian Planting	Finn Creek T12NR9WS30	46.29.403 123.49.957	Weyer-haeuser	Riparian Restoration	$50,000-$100,000	14.34
#9	**Project #21** A-4100 Road Bridge Removal	Middle Nemah T11NR9WS15	46.26.359 123.46.352	WDNR	Bridge Removal	$50,000-$100,000	14.01
#10	**Project #22** A-4400 Road Bridge Removal	Middle Nemah T11NR9WS15	46.25.942 123.46.413	WDNR	Bridge Removal	$50,000-$100,000	14.01
#11	**Project #1** Mid-Nemah Road Abandonment	Middle Nemah T12NR10WS35	46.29.231 123.53.166	Unknown	Road Abandonment	$50,000-$100,000	14.0
#12	**Project #13** N. Nemah Windthrow	North Nemah T12NR9W30	46.28.589 123.46.890	Weyer-haeuser	Windthrow Response	$50,000-$100,000	13.84
#13	**Project #24** North Nemah Stream Bank Restoration	North Nemah T11NR9WS2	46.27.948 123.45.951	Weyer-haeuser	Stream Bank Restoration	$50,000-$100,000	13.84
#14	**Project #2** Mid-Nemah LWD Placement	Middle Nemah T12NR10WS26	46.29.101 123.53.010	Weyer-haeuser	LWD Placement	$50,000-$100,000	13.67
#15	**Project #25** North Nemah Spawning Survey	North Nemah T12NR9WS32	46.30.180 123.50.596	Weyer-haeuser	Spawning Availability Survey	$50,000-$100,000	13.51
#16	**Project #8** Bridge Washout	Middle Nemah T11NR9WS15	46.26.737 123.47.426	WDNR	Bridge Removal	$100,000-$500,000	13.34
#17	**Project #16** SSHEAR Analysis of two Culverts	South Nemah T11N9WS18	46.26.274 123.50.303	WDNR	Passage Barrier Analysis	$50,000-$100,000	12.99
#18	**Project #10** Finn Creek Riparian Conversion	Finn Creek T12NR9WS21	46.30.039 123.47.410	Weyer-haeuser	Riparian Hardwood Conversion	>$50,000	11.67
#19	**Project #9** Williams Creek Riparian Restoration	Williams Creek T12NR10WS14	46.31.769 123.51.858	Unknown	Riparian Restoration	>$50,000	10.67

Bibliography

Abbe T. B. and D. R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. Regulated Rivers: Research & Management, Vol. 12, 201-221.

Ashbrook, C. and H. Fuss. 1996. Hatchery operation plans and performance summaries. Volume II Number 2 Coast. Washington Department of Fish and Wildlife, Olympia, WA.

Barndt, S., T. Coley, J. Taylor, B. Ensign. 2000. Physical and Biological Characteristics, and Salmonid Restoration Potential, of Seven Willapa National Wildlife Refuge Waterbodies. US Fish and Wildlife Service, Vancouver WA. 13pp

Beamer, E. T. Beechie, B. Perkowski & J. Klochak. 2000. *Application of the Skagit Watershed Council's Strategy: River Basin Analysis of the Skagit and Sammish Basins: Tools for Salmon Habitat Restoration and Protection*. Skagit Watershed Council, Mt. Vernon, WA 79 pp.

Beechie, T. J. and T. H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society 126:217-229.

Beschta, Robert L. 1991. Stream Habitat Management for Fish in the Northwestern United States: The Role of Riparian Vegetation. American Fisheries Society Symposium 10:53-58.

Clark, J. 1995. Appendix B Vesta-Little North Watershed analysis surface erosion assessment. *In* Vesta-Little North Watershed Analysis. Weyerhaeuser Company. Federal Way, WA.

CWC Coastal Watersheds Consulting. 1998. A Watershed Level Conservation and Restoration Plan for the Bear River, Pacific County, WA. US Fish and Wildlife Service, Lacey, WA. 25pp

Federal Interagency Stream Corridor Restoration Working Group. 2000: *Stream Corridor Restoration Principles, Processes and Practices.* By the Federal Interagency Stream Corridor Restoration Working Group GPO Item No. 0120-A; SuDocs NoA 57.6/2:EN3/PT.653. ISBN-0-934213-59-3. 605pp.

Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem assessment: an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team to President Clinton. USDA Forest Service. Portland, Oregon.

Herger, L. 1995. Vesta-Little North River watershed analysis fish habitat assessment appendix F. *In* Vesta-Little North Watershed Analysis. Weyerhauser Company, Federal Way, Washington.

Herger, L. 1997. Lower North River watershed analysis fish habitat assessment appendix F. *In* Vesta-Little North Watershed Analysis. Weyerhauser Company, Federal Way, Washington.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Responses of salmonids to habitat change, p. 483-518. In W. R. Meehan (ed.), Influences of Forest and Rangeland Management on Salmonid Fisheries and Their Habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

Herger, L. 1995. Vesta-Little North River watershed analysis fish habitat assessment appendix F. In Vesta-Little North River Watershed Analysis. Weyerhaeuser Company, Federal Way, WA.

Hood Canal Coordinating Council. 2000. Salmon Recovery Strategy for the Hood Canal and the Eastern Strait of Juan de Fuca. 64pp.

Jordan, D. 1995. Vesta-Little North River watershed analysis riparian function assessment appendix D. In Vesta-Little North River Watershed Analysis. Weyerhaeuser Company, Federal Way, WA.

Kitsap County. 2000. "Kitsap Peninsula Salmonid Refugia Study". Port Orchard WA.

Martin, D. 1997. Module F fish habitat assessment Palix watershed. In Palix Watershed Analysis Resource Assessment Report and Prescriptions. Rayonier Northwest Forest Resources, Hoquiam, Washington.

Montgomery, D. R., J. M. Buffington, R. D. Smith, K. M. Schmidt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research 31(4):1097-1105.

National Marine Fisheries Service (NMFS), 1995. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. Draft Non Federal Version November 2, 1995. The National Marine Fisheries Service Environmental and Technical Services Division Habitat Conservation Branch. 28pp.

Northwest Indian Fisheries Commission. 1996. Literature Review and Monitoring Recommendations for Salmonid Spawning Habitat Availability. Publication TFW-AM-9-96-002.

Phinney, L.A. and P. Bucknell. 1975. A Catalog of Washington Streams and Salmon Utilization. Volume 2 Coastal Region. Washington Department of Fisheries, Olympia, WA.

Skagit Watershed Council. 1998. *Habitat Protection and Restoration Strategy*. Skagit Watershed Council Mt. Vernon, WA 56pp

Smith, C. 1999. Salmon and Steelhead Habitat Limiting Factors in the Willapa Basin. Washington State Conservation Commission. Lacey WA 98pp.

Spence, B. C., G. A. Lomnicky, R. M. Hughes and R. P. Novitzki. 1996. "An Ecosystem Approach to Salmonid Conservation". TR-4501-96-6057. ManTech Envronmental Research Services, Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon).

Suzumoto, Bruce K. 1992. Willapa Fisheries Enhancement Project. Prepared for the Willapa Alliance.

Washington Department of Fish and Wildlife. 1998. Fish Passage Barrier Assessment and Prioritization Manual, Washington Department of Fish and Wildlife Habitat and Lands Services Program, Salmonid Screening, Habitat Enhancement, and Restoration Division (SSHEAR) 57pp plus appendicies

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Indian Tribes. 1994. 1992 Washington State Salmon and Steelhead Stock Inventory Appendix Two Coastal Stocks. Olympia, Washington.

Washington State Forest Practice Board (WFPB). 1996. Standard methodology for conducting watershed analysis under Chapter 222-22 WAC, Version 3.1. Timber/Fish/Wildlife Agreement and WFPB. Olympia, WA.

Willapa Alliance. 1998. A Vision for the Recovery of Willapa Salmon. The Willapa Alliance, South Bend, Washington. 32 pp.

Willapa Alliance. 1998. Willapa Indicators for a Sustainable Community. The Willapa Alliance, South Bend, Washington 41 pp.

(1996). *Ecological Restoration: A Tool To Manage Stream Quality*. [Online]. Available: http://epa.gov/OWOW/NPS/Ecology/chap1.html. Doc#: EPA841-F-95-007.

(1995). *A Phase I Inventory of Current EPA Efforts to Protect Ecosystems*. [Online]. Available: http://www.epa.gov/docs/ecoplaces.