A System for Prioritizing Water Resource Inventory Areas in Western Washington for Protection and Restoration of Wild Salmonids

August 1999

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Report to the Washington State Joint Natural Resources Cabinet

from the Interagency Science Advisory Team

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Executive summary

In January 1999, Governor Locke released a draft of Washington's Statewide Salmon Recovery Strategy (SSRS) that was developed by the Joint Natural Resources Cabinet (Joint Cabinet). The purpose of the SSRS is to protect and restore wild salmonids and their habitats. Accomplishing the goals of the SSRS will require effective approaches to identify and prioritize recovery activities. The draft SSRS described the need for prioritization and allocation of resources that would effectively contribute to salmonid recovery. To that end, the draft SSRS outlined an initial procedure, analysis, and list of priority WRIAs (Water Resource Inventory Areas - the fundamental, watershed oriented geographic units used in the draft SSRS) for distribution of new funding for habitat protection and restoration efforts across the state.

The Interagency Science Advisory Team (ISAT) was created by the Joint Cabinet to provide science support in development of the SSRS. In the context of a longer term, more comprehensive statewide need to address all limiting factors statewide, the Joint Cabinet directed ISAT to extend the prioritization system to address the following short term objective: **develop and refine the scientific principles for determining which WRIAs are the highest priorities for use of new funding for salmonid <u>habitat</u> protection and restoration in <u>western Washington</u>**. This document addresses the short term objective only.

An similar effort could be extended to WRIAs in eastern Washington.

It is important to emphasize several points about this report. First, the system described here for prioritizing WRIAs for habitat protection and restoration is intended to provide a reasonable, scientifically based coarse-scale approach to prioritization needs, making use of available information. It proposes and illustrates an option for possible use by decision-makers in their efforts to determine where protection and restoration actions might produce the most effective and efficient outcomes in general for the state's salmon, steelhead, trout, and char. This system was not intended to represent the only approach to prioritization issues. Policy overlays or alternative technical approaches may also be appropriate.

Second, it is important to emphasize that this system is not intended to provide a direct approach to all needs and conservation responses to listings and/or proposed listings under the Endangered Species Act (ESA). An attempt to more directly address priorities to address ESA issues would be most effective once recovery goals for salmonid populations and ESUs and related habitats are available. Technical and policy guidance associated with recovery goals was not available for ISAT's use in development of this system.

Finally, the framework is not intended to provide a risk assessment, or to represent an analysis of critical high risk fish or information categories. There may indeed be circumstances that call for emergency efforts, but they should not be expected to be identified through this system.

Considerable scientific and policy guidance for developing a ranking system for WRIAs in western Washington was drawn from the draft SSRS. The draft SSRS recognized that protection of higher quality salmonid and/or habitat conditions that are at risk of degradation will generally be more effective and less costly than restoring or rehabilitating conditions after they are degraded. ISAT's approach was built on this foundation.

ISAT's prioritization methodology used two categories of information: salmonid population components, and salmonid ecosystem components. To be used in the prioritization system, information components had to meet the several conditions:

1. represent general measures or indices of salmonid or ecosystem conditions,
2. be available for essentially all WRIAs in western Washington,
3. be available from existing databases or scientific studies, and
4. be of sufficient and consistent quality for all WRIAs.

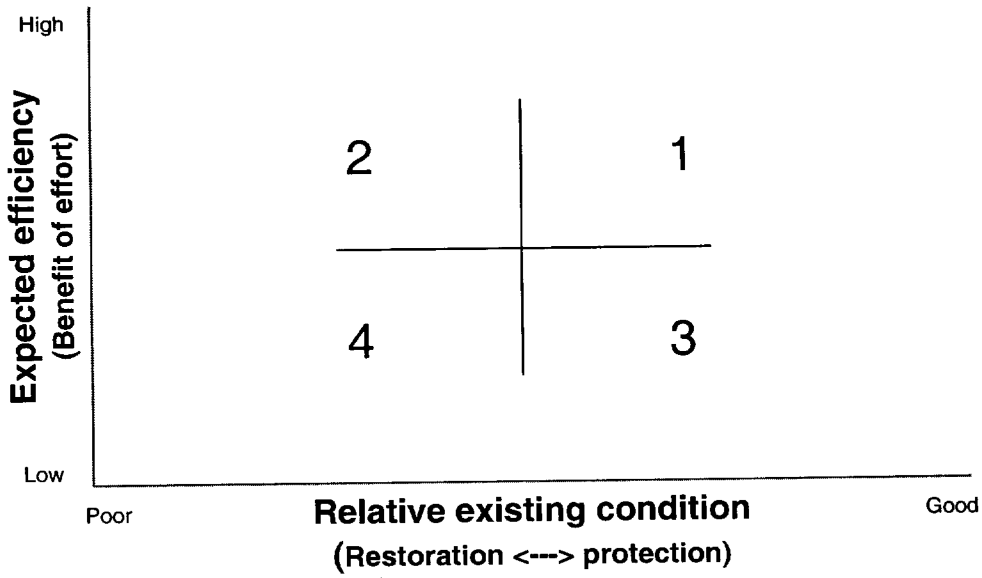
Consistent with these conditions, a scoring system was developed and applied to each information component. Scores (unweighted) were assigned according to the extent to which values were favorable for wild salmonids and/or their ecosystems. Total scores were then developed for each WRIA.

Scores were compiled to characterize the relative existing conditions for salmonids and their habitats, and to characterize the relative expected efficiency and benefits of recovery efforts to wild salmonids. Existing conditions were estimated based on 12 information components related to the status and various features of salmonids and their environments in each WRIA, including spawner numbers, and components of habitat such as: water quality and quantity, and the amount of late seral stage forested land. Expected efficiency for each WRIA was estimated based on 12 information components such as: the number of healthy stocks, the ability to distinguish hatchery from wild stocks, and the extent of urban development. The idea here was that expending effort (and/or spending money) in WRIAs, for example, with many healthy stocks or those in which means to distinguish hatchery from wild stocks, would be more efficient and beneficial than spending equal effort in WRIAs having fewer healthy stocks, or where there were more mixed hatchery and wild stocks.

This prioritization system assumes that the information components as used lead to reliable characterizations of existing conditions, and provide reasonable expectations of relative efficiencies and benefits between WRIAs. Not surprisingly, these measures are correlated (albeit imperfectly); WRIAs with good existing conditions also tend to rank high in terms of efficiencies and benefits. ISAT's prioritization system suggests that expending effort or money on the WRIAs with the best habitat and salmonid conditions is also the most efficient expenditure all else being equal.

Importantly, this prioritization system was also designed to help identify WRIAs in which recovery efforts might best emphasize protection vs. restoration. This should not be taken to imply that restoration will not work but rather that there is more uncertainty and thus greater risk inherent in restoration activities compared to protection.

The conceptual diagram below illustrates the framework within which WRIAs were viewed relative to one another, considering the expected efficiency and benefit of conservation efforts, and the relative existing conditions pertaining to the need for restoration and/or protection.



Placement of the partitions between the four quadrants or zones would ultimately be based on policy goals, species/ESU recovery goals, implementation strategies, and other considerations. For this report, partitions were placed at the mid-points among the spread of WRIA point along the vertical and horizontal axes. In general, the zones represent:

- **Zone 1** would tend to include WRIAs that would have much to gain in terms of efficiency and benefit from conservation efforts, and in comparison to zone 2 would tend to favor protection activities.
- **Zone 2** would also have much to gain in terms of efficiency and benefit but since the starting conditions are poorer, those activities would be expected to entail more emphasis on restoration than protection.
- **Zone 3** would include WRIAs that are in relatively good condition initially, but relative to zones 1 and 2, efficiencies of activities would not be as high as in zones 1 and 2.
- **Zone 4** would contain WRIAs where efficiency is relatively low and initial conditions suggest that restoration is more likely to be more necessary and effective than protection.

When information from each WRIAs is viewed in terms of the above conceptual diagram, the following generalizations about expected efficiencies, effectiveness, and types of efforts that might be undertaken in western Washington were found:

- Recovery efforts directed at WRIAs of the Coastal region (19-24), and Stillaguamish (5) WRIAs would generally be expected to produce the greatest efficiency and benefits to wild salmonids.

- In contrast, the efficiency and benefit of recovery efforts directed at WRIAs 9 (Green-Duwamish), 8 (Cedar-Sammamish), 10 (Puyallup), 26 (Cowlitz) would be expected to be lowest.

- There are few WRIAs with relatively good existing conditions, whose benefits from recovery efforts would be expected to accrue from a primary emphasis on protection. These few include WRIA 4 (Upper Skagit), 16 (Hood Canal), 19 (Lyre-Hoko), and 21 (Queets-Quinault).

- In contrast, there are many WRIAs with poorer conditions in which the most beneficial results from recovery efforts would accrue from an emphasis on restoration. Importantly however, in less than half of these WRIAs would efficiency and benefits be expected to be high relative to other WRIAs. WRIAs in which efficiencies and benefits from an emphasis on restoration would be expected to be highest include WRIA 3 (Lower Skagit-Samish), 11 (Nisqually), 7 (Snohomish), 1 (Nooksack), and 14 (Kennedy-Goldsborough).

These results should not be interpreted as proof that some WRIAs are more important than others. This prioritization can provide guidance to help direct recovery efforts between and within WRIAs. In general, ISAT concludes that the majority of WRIAs in western Washington would benefit most from restoration and that the relatively few WRIAs that would benefit from an overarching emphasis on protection are associated with the Olympic Peninsula and northern Washington coast.

This prioritization framework should be regarded as a work in progress, subject to revision as new scientific information and/or approaches are identified. To that end, ISAT identified several technical needs for future improvements, including:

- As available, include specific recovery goals for salmonid populations and ESUs, and habitat conditions at appropriate scales in space and time, toward which priorities could be targeted.
- Develop and use GIS and/or other information management technology to manage information and perform and display quantitative analyses.
- Add high priority new and refine existing information and data sets.
- More explicitly incorporate means to address capacity for salmonid and habitat improvement.
- Consider alternative approaches to weighting factors, and include a sensitivity analysis.
- Address finer scales of spatial resolution.

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Acknowledgments

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Introduction

Over 75% of the area of Washington State is now covered by the listings of wild salmon, trout, and/or char[1] under the federal Endangered Species Act (ESA). In January, 1999, Governor Locke released a draft of Washington's multifaceted Statewide Salmon Recovery Strategy (SSRS), developed over the last year by the Joint Natural Resources Cabinet (Joint Cabinet). The purpose of the SSRS is to protect and restore wild salmonids and their habitat. This includes not only restoring those stocks listed under the ESA, but protecting healthy stocks to prevent the need to list or respond to listing decisions in the future. Through various approaches the draft SSRS addresses all 4Hs: harvest, hatcheries, hydropower, and habitat; however, its focus is habitat. The investment by the Governor and the Joint Cabinet in addressing the goal of the SSRS represents the first coordinated statewide approach to protect and restore habitat for wild salmonids.

Accomplishing the goals of the SSRS and its associated implementation plans will take considerable effort, will require forming new coalitions and ways of working together, will require facing difficult choices, and will place new demands on limited fiscal resources. Effective approaches will be needed to identify and prioritize recovery activities that can be expected to do the most good for recovery of wild salmonids at appropriate spatial scales (project site, watershed[2], region[3], Evolutionarily Significant Units (ESUs)).

Scientifically-based approaches and tools to help prioritize conservation and recovery efforts for salmonids at risk are receiving increasing attention in the scientific literature (Allendorf et al. 1997; Lunetta et al. 1997; Mobrand et al. 1997; WDFW 1997; Moyle and Randall 1998). Bradbury (1995) outlined a framework to prioritize watershed recovery efforts in Oregon. Prioritization efforts may involve many elements, either individually or collectively, including: (1) factors affecting salmonid production, (2) evaluations of biologic and/or habitat conditions, (3) species and/or stocks, (4) cost and benefit analyses, and (5) emphasis at different spatiotemporal scales (e.g., project, watershed, or metapopulation/ESU/region).

The draft SSRS contains a chapter entitled *Priorities for use of new funding for habitat protection and restoration* (chapter III.F.4.). That chapter clarifies an initial context and need for prioritization and allocation of resources to effectively and efficiently benefit salmonid recovery. It

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[1] Salmon, steelhead, trout, and char are members of the family Salmonidae. These fish are known collectively as salmonids. As in the draft Statewide Salmon Recovery Strategy, any use of the term salmon is intended to mean salmon, steelhead, trout, and char - salmonids.

[2] The term watershed is generally reflected in the draft Statewide Salmon Recovery Strategy in the context of Water Resource Inventory Areas (WRIAs). WRIAs are the fundamental watershed unit used in this prioritization framework.

[3] Use of the term regions is intended to be consistent with its use in the draft Statewide Salmon Recovery Strategy, wherein it refers to salmon recovery regions across the state.

reflects the policy options and decisions of the Joint Cabinet, and is based on the scientific principles outlined in the "Science as a Guide" chapter (III.A) of the draft SSRS.

In general, the long-term prioritization goal for Washington's salmonids, consistent with the draft SSRS, is to:

> ***Ensure that funding is used effectively for activities that have the highest likelihood of contributing to recovery in the shortest possible time, within the constraint of available resources and capabilities.***

The prioritization framework described in the draft SSRS identifies the overarching need for development and application of a comprehensive approach to guide efforts for all 4Hs (habitat, harvest, hatcheries, hydropower) at multiple scales (within and between regions and watersheds). **Figure 1** illustrates salmonid recovery regions across Washington as identified in the draft SSRS. Water Resource Inventory Areas (WRIAs) are the fundamental watershed-oriented geographic unit used in the draft Statewide Salmon Recovery Strategy.

The emphasis of the framework described in the draft SSRS was limited to habitat protection and restoration only. It outlined an initial procedure, analysis, and list of priority WRIAs for distribution of new funding **between WRIAs** across the state. As described in the draft SSRS, separate processes to prioritize habitat protection and restoration efforts for activities to address factors limiting wild salmonid production **within WRIAs** are needed. To that end, in 1998 the legislature passed and Governor Locke signed, ESHB 2496. That legislation created processes to identify limiting factors and analyze critical paths to address them under the auspices of the Washington State Conservation Commission. In 1999, the legislature passed additional legislation pertaining to management and distribution of funds intended to support salmonid recovery efforts.

The Interagency Science Advisory Team (ISAT) was created by the Joint Natural Resources Cabinet to provide scientific support in development of the SSRS. ISAT is comprised of scientists from Joint Cabinet agencies and other scientists invited by the Joint Cabinet.

Early in 1999, the Joint Cabinet requested that ISAT assist in the effort to develop a prioritization approach by reviewing scientific aspects and refining the foundation provided in the draft SSRS. The results this work are intended for use in development of policy and administrative guidance for the allocation of resources (e.g., state, federal, other) and other salmonid recovery efforts.

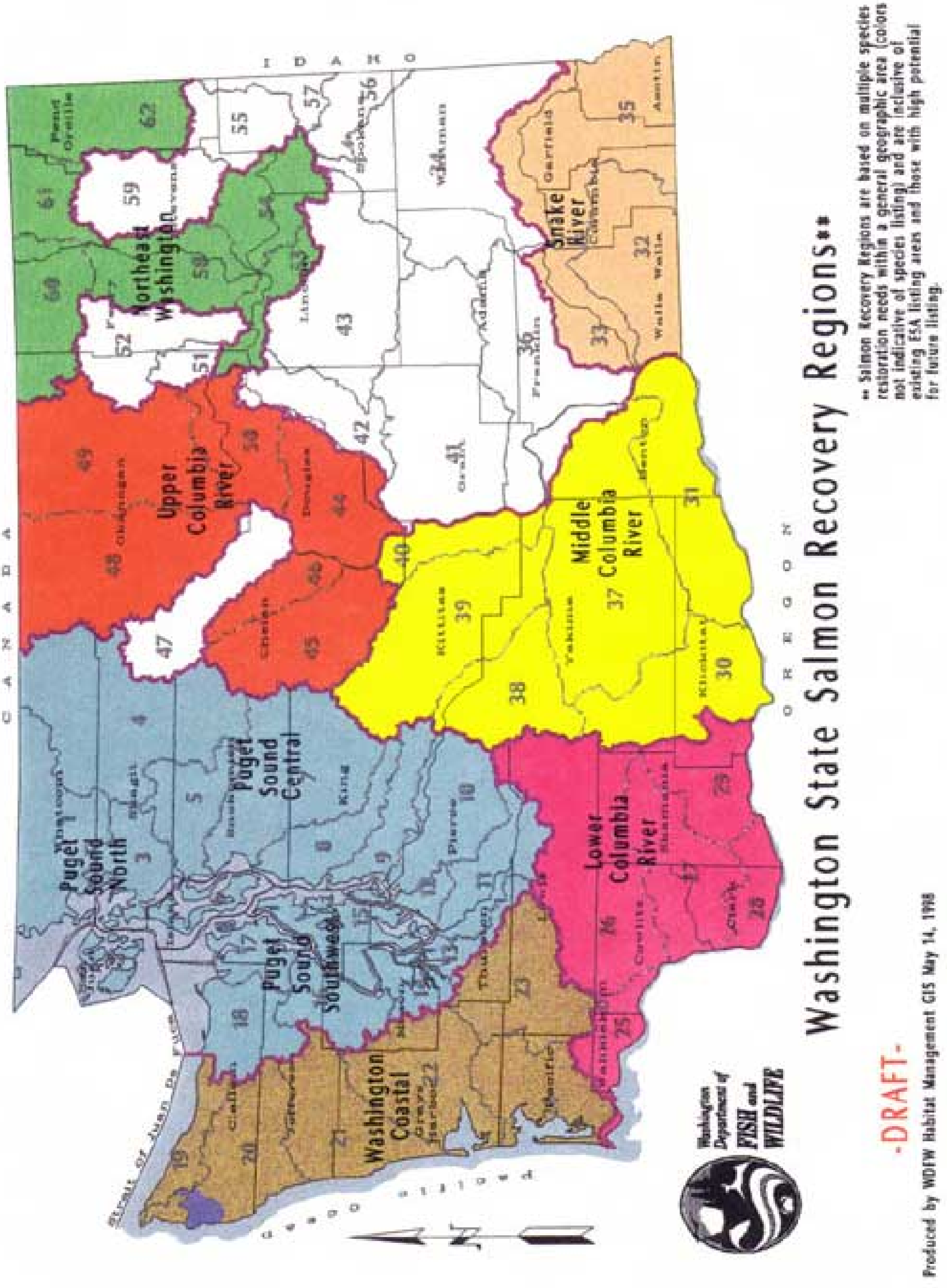

Figure 1. Map of Washington showing Water Resource Inventory Areas and salmon recovery regions. From the draft Statewide Salmond Recovery Strategy.

The purpose of this document is to extend the prioritization effort put forth in the draft SSRS and support the short-term objective noted below. Consistent with the draft SSRS, WRIAs were the smallest spatial scale used in this prioritization framework. This framework continues to focus on habitat; identification, assessment, and synthesis of additional information would be needed to address all four Hs in future prioritization activities.

- **Short-term objective:** Develop and refine the scientific principles and basis for determining which WRIAs are the highest priorities for use of new funding for salmonid habitat protection and restoration in western Washington.

- **Long-term objective:** Adapt and expand the scientific principles and approach to guide use of resources to address all four Hs across WRIAs statewide.

It is important to note that this habitat-oriented WRIA prioritization framework for salmonids in western Washington could be adapted for use in eastern Washington.

As defined in the draft SSRS, the term habitat "**protection**" encompasses efforts to prevent loss or degradation of habitat and its functions through actions, such as acquisition of property and development rights, to preserve habitat and aquatic salmonid communities, including life history diversity. Protection also includes actions to prevent loss or degradation of either high quality habitat or habitat that has already been degraded. The term "**restoration**" is defined to encompass efforts to correct to some level loss or degradation of habitat and its functions that has occurred, including efforts to rehabilitate some portion of habitat functions that have been lost or degraded. Restoration of habitat and its functions may also occur passively, without active intervention, if the conditions causing the loss or degradation are prevented or corrected. Most actions can be classified as either protection or restoration; but a given action may have both protective and restorative benefits.

It is important to pause and emphasize several points about this report. First, the system described here for prioritizing WRIAs for habitat protection and restoration is intended to provide a reasonable, scientifically based coarse-scale approach to prioritization needs, making use of available information. It proposes and illustrates an option for possible use by decision-makers in their efforts to determine where protection and restoration actions might produce the most effective and efficient outcomes in general for salmon, steelhead, trout, and char. ISAT's system was not intended to represent the only approach to prioritization issues. Policy overlays or alternative technical approaches may also be appropriate.

Second, it is important to emphasize that this system is not intended to provide a direct approach to all needs and conservation responses to listings and/or proposed listings under the Endangered Species Act (ESA). An attempt to more directly address priorities to address ESA issues would be most effective once goals for specific salmonid populations or habitat recovery goals for watershed, regions, ESUs, or groups of ESUs are available. Technical and policy guidance associated with recovery goals was not available for ISAT's use in development of this system.

Finally, the framework is not intended to provide a risk assessment, or to represent an analysis of critical high risk fish or information categories. There may indeed be circumstances that call for emergency efforts, but they should not be expected to be identified through this system.

Figure 2 provides a more detailed illustration of the regions, WRIAs, and major river systems in western Washington.

Scientific principles and conceptual framework

The ecosystem and watershed-oriented scientific principles outlined in the "Science as a Guide" chapter of the draft SSRS (chapter III.A) were used to develop this prioritization framework. These principles emphasize the need to address both salmonid protection and restoration in a context that considers the continuum of habitats that salmonids may be subjected to during their life cycle (i.e., upland areas, tributaries, mainstems, estuaries, nearshore marine areas, ocean, and their interconnections). The scientific principles also emphasize the structure afforded by biological and salmonid genetic diversity, and the role humans play in influencing the condition of Washington's salmonid ecosystems. They emphasize the need to address causes of degradation of watersheds and ecosystem functions and processes, not the symptoms of degradation, presuming recovery of properly functioning salmonid populations and habitat systems is the goal.

From a long term perspective, salmonid conservation and recovery will be most efficient and effectively beneficial if protection efforts are emphasized. As in the case for the medical profession, common sense tells us it will be more effective and less expensive to keep a patient

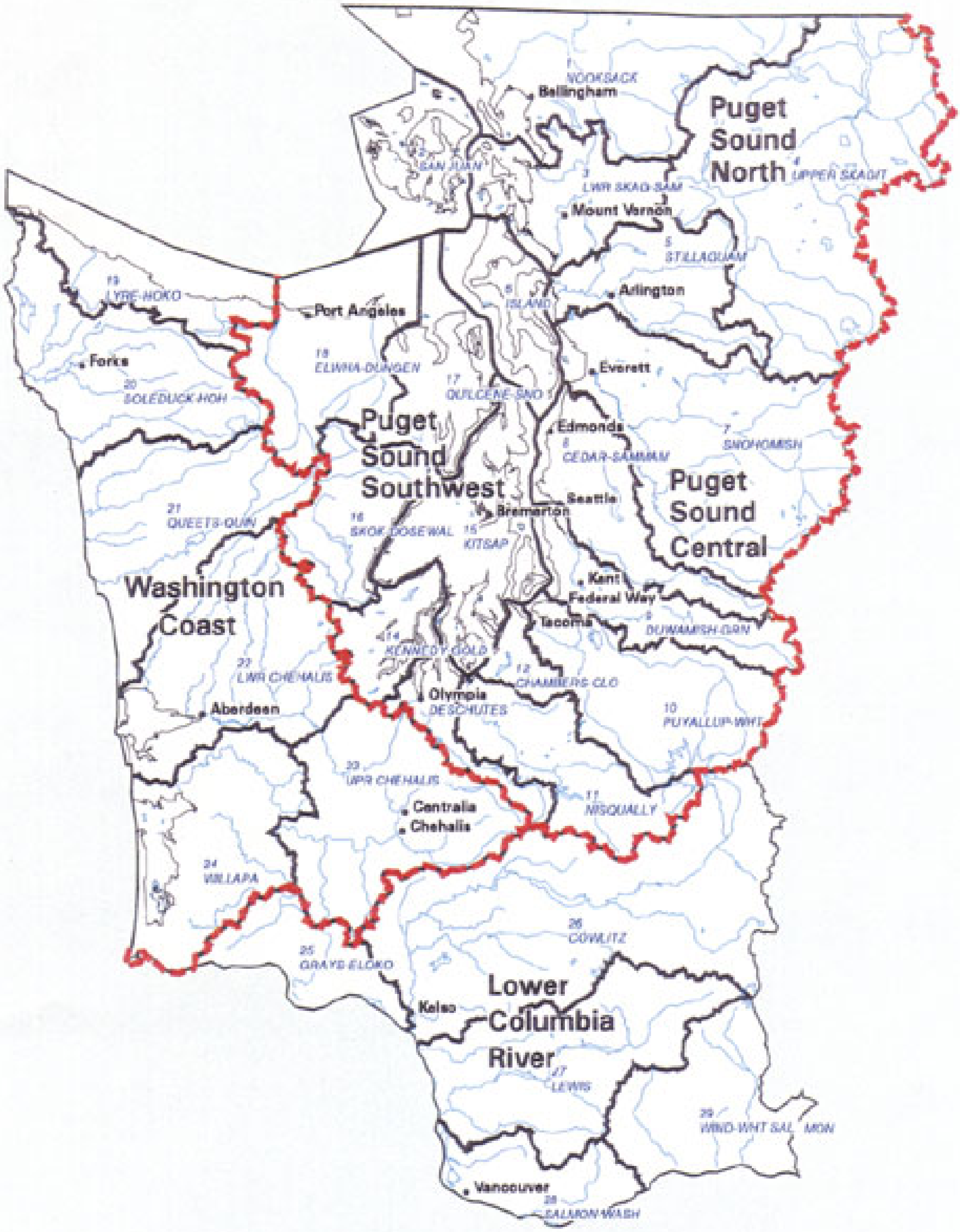

Figure 2. Map of western Washington showing salmon recovery regions, Water Resource Inventory Areas, major river systems, and communities.

from becoming ill or injured in the first place than to try to heal or repair them afterwards. The same is the case for salmonids and their ecosystems. Once degradation has occurred to the extent that restoration approaches are needed, such approaches typically require substantial investments to accrue benefits that are even marginally similar to those present before the degradation occurred in the first place. In addition, protection approaches are generally more reliable and likely to succeed than restoration. Although ISAT acknowledges there are many ongoing and dedicated efforts to improve efficient and effective design and implementation of restoration practices, the efficacy of such practices remains largely unproven in the scientific literature (e.g., Reeves et al. 1997, and references therein), especially in terms of their ability to achieve and sustain long term recovery of salmonids and their ecosystems. An orientation toward protection approaches has been repeatedly articulated in the scientific literature (e.g., FEMAT 1993; National Research Council 1992, 1996; Frissell 1997; McGurrin and Forsgren 1997).

The draft SSRS (chapter III.F.4) proposed to emphasize protection over restoration in a policy context. Beyond a general base allocation of 20%, the stated priority for use of new funds for habitat restoration and protection was 60% for protection and 40% for restoration efforts. These percentages resulted from Joint Cabinet deliberations regarding policy issues and options, as guided by the best available scientific information. It was not ISAT's charge to review the appropriateness of these percentages. Instead, ISAT's intent was to help identify priority WRIAs within which restoration and/or protection activities would be expected to contribute the most to effective recovery, in the shortest possible time, and using the least amount of effort/resources.

Consistent with the goal of this prioritization framework is a fundamental emphasis on the efficient use of available resources. The framework was designed to allow ranking of individual WRIAs on the basis of assumptions about efficiencies. If, on the other hand, efficiency is not the desired way to view recovery, then ISAT's intent was to provide adequate information about the elements of a ranking system and related information that will allow WRIAs to be ranked according to alternative criteria (e.g., species emphasis, rivers with moderate amounts of human disturbance). It was also ISAT's intent to acknowledge the limitations of the approach used, and to provide recommendations for consideration in possible future iterations.

Salmonid life cycles and habitat requirements

The discussion below was extracted from the "Science as a Guide" chapter of the draft Statewide Salmon Recovery Strategy. It provides a very brief introduction to the life cycles and habitat requirements of Washington's salmonids. It is intended to encompass several species of the salmonid genus *Oncorhynchus* including: chinook, pink, coho, chum, sockeye, steelhead/rainbow trout, and coastal and westslope cutthroat trout. In addition, wild bull trout and Dolly Varden, which are char of the genus *Salvelinus*, also exist in the state. These species may have anadromous and non-anadromous forms. Each species is comprised of many component stocks and populations, which vary from one another in their genetic, life history, and other characteristics.

Anadromous salmonids spend part of their lives in freshwater where they spawn, their eggs incubate and hatch, and juveniles rear. After varying periods of freshwater residence, depending on the species, the juveniles go to marine environments as "smolts" to feed and grow to adulthood. Ocean-going salmonids acquire most of their adult size during their ocean residence. Except for steelhead and the resident trouts and char, all Pacific salmon die after returning to spawn. Upon death, anadromous salmonids return critically important marine derived nutrients to our watersheds, nutrients that the productive potential of our salmonid stocks may depend on. Trout have the potential to survive to spawn more than once. Non-anadromous salmonids stay in freshwater their entire lives, but seldom achieve as large a size as the ocean forms, at a given age.

All species of Washington's salmonids have basic requirements for them to exist. If any, or all, of these requirements are not maintained in a healthy state, then populations will decline over time and eventually either go extinct or change in character. These requirements are:

1. Salmonid stocks of sufficient abundance and genetic diversity with which to build on.

2. Upstream and downstream access to and from spawning and rearing habitats. This includes all blockages from large hydroelectric dams on large rivers to road culverts or diversions on small streams.

3. Abundant clean and cool water. Salmonids evolved in cold water free of toxics and other pollutants.

4. An accessible food supply in freshwater, estuaries, and in the ocean. This usually comes from a healthy riparian ecosystem and an abundance of salmon carcasses on the spawning beds.

5. Abundant clean gravels in which to spawn. This means gravels without fine particulate sands in excessive amounts.

6. Habitat complexity and quality in the form of properly functioning and dynamic systems with deep pools and shallow riffles, as well as properly functioning estuary and ocean environments.

7. A balanced population of natural predators (i.e., insects, fish, birds, and mammals). Salmonids have evolved in the presence of predators, which impose an important selective force which contributes to the fitness of salmonid stocks.

In summary, healthy salmonids need healthy watersheds and healthy functioning ecosystem conditions. Key overarching needs include diverse biological communities, genetic diversity, and functional watershed and ecosystem processes. All factors that impact the needs of salmonids (e.g., harvest, hatcheries, habitat, hydropower) must be addressed to ensure recovery and protection of healthy stocks, their watersheds, and their ecosystems.

Conceptual approach and methods

A fundamental assumption in conservation or recovery planning intended to improve conditions for degraded populations and their habitats is that the health of population(s)/species of interest will respond positively to the reduction or elimination of factors causing the declines. In other words, the health of salmonid populations/species is a function of factors affecting their production. These factors may be individually and cumulatively associated with human and/or naturally occurring activities and processes. This relationship is illustrated conceptually in **Figure 3** below.

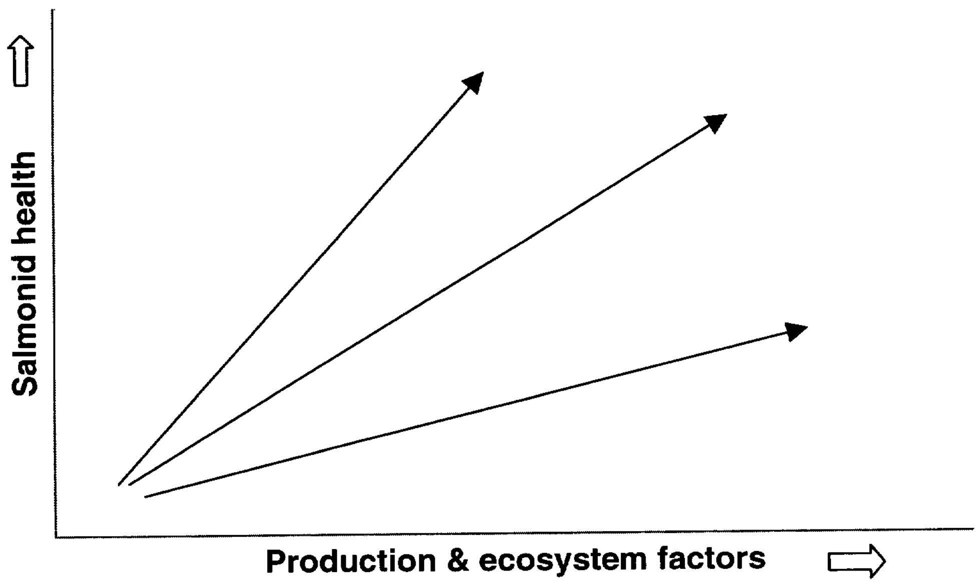

Figure 3. Conceptual diagram illustrating the relationship between salmonid production and ecosystem factors and health of salmonid populations.

To address the short-term objectives of this prioritization exercise (habitat and western Washington emphasis), ISAT identified two major categories of information associated with the above conceptual relationship. These are: (1) **salmonid populations**, and (2) **salmonid ecosystems**. It is important to note that economic or cost factors were not considered in ISAT's analyses.

Information related to each of the two categories was used to assess the relative extent to which recovery efforts among WRIAs for salmonids and/or their ecosystems might be expected to efficiently benefit wild salmonids in the shortest possible time. In addition, information was used to ascertain the extent to which the relative emphasis of recovery efforts might rely on habitat protection and/or restoration approaches.

Informational components within categories were considered for inclusion if they were available for WRIAs across western Washington. ISAT recognized that information for elements not included here may have been available for many areas, but if information was not available for all of western Washington, they were not included in this assessment. Available information was assembled, analyzed, and rated for individual components of information for each WRIA in western Washington under each of the following two categories:

I. the importance of **salmonid populations** in their ecosystems to their respective evolutionarily significant units (ESU) and species.
    - this category characterizes the status and various features of salmonids and their fishery management context.

II. the importance of the **ecosystem** to salmonids.
    - this category characterizes the habitat and environmental context for salmonid ecosystems/watersheds, and the relative extent to which various elements might benefit from protection and/or restoration efforts.

Organizing information in these categories provides a way to help conceptualize how to compile and relate information regarding protection and restoration of the capacity, productivity, and diversity of salmonids and their habitats to achieve the goal of the draft SSRS. For example, maintaining or restoring quality habitat will not be effective if passage obstructions or harvest in fisheries do not allow full use of the available habitat. In addition, the rate of habitat degradation has to be less than the rate of habitat conservation and improvement for net gains to occur. It is known that different watersheds and associated fish populations have been altered in different ways; some more, some less. Restoring lost habitat, especially those areas affected by major dams or other large un-natural blockages or human impacts, may be impractical without extraordinary and sustained effort and costs over the long term. In contrast, it may be very feasible to improve passage barriers (e.g., road culverts), modify channel constraints imposed by dikes, or reconnect off-channel areas to increase habitat complexity in ways that will benefit salmonids for one or more stages in the continuum of habitats required to support salmonid life cycles.

Pursuing the approach described above required completing a sequence of steps. Some or all of these steps would be expected to be reviewed as the prioritization framework is iteratively improved over time. These steps include: (1) literature review of recent approaches and methodologies and identification of specific information needs and elements; (2) identification and acquisition of the best data available to meet those needs; (3) development of an analytical approach and scoring/ranking system; (4) system verification and testing; (5) revision of systems as needed; (6) completion of analyses, synthesis, and document/report preparation. ISAT has engaged each of these steps.

ISAT used an analytical approach and rationale in creation of a scoring system that was based on a coarse-scale, multi-species assessment. That required qualitatively or quantitatively sorting each set of data or information into three general subgroupings associated with how favorable a condition of circumstance would be for wild salmonids and/or their ecosystems (e.g., high favorability, medium, low favorability). Unless otherwise noted, for each WRIA each subgrouping was then assigned a point score (e.g., high favorability = 10, medium = 5, low favorability = 0) for that respective component. ISAT acknowledges that this approach oversimplifies many issues. The approach may tend to mask slight but important variations. However, this approach is consistent with ISAT's goal to provide a coarse, multispecies assessment of WRIAs across western Washington.

Assumptions

ISAT made various assumptions in developing and utilizing this prioritization framework. These include:

1. The development and refinement of tools to aid in the prioritization of resources must be based on available information. Thus an iterative approach to prioritization is required wherein improvements should be made as new information, approaches, or analyses become available. This framework builds on the prioritization scheme outlined in the draft SSRS.
2. The information for individual components is of sufficient consistency and quality across WRIAs in western Washington to achieve the purposes of this exercise.
3. Information pertaining to some components is not applicable in two WRIAs (WRIA 2-San Juan and 6-Island), and is unavailable in another (WRIA 29-Wind-White Salmon). The influence of these missing values on the outcome of the prioritization exercise is negligible.
4. The information on individual components reflects true variation among WRIAs. In other words, the characteristics of species and their habitats are highly variable within and among WRIAs; however, the coarse-scale approach used in this exercise is sufficient to discriminate relationships among WRIAs.
5. The use of various informational components that were not completely independent from one another is appropriate for the purposes of this prioritization exercise.

Informational components

The information used in the two categories in this prioritization framework is shown below in outline form. More detail defining each component, clarifying the source and limitations of the information, and the scoring system used for each is contained in **Appendix 1. Appendix 2** contains data summaries, scores, and breakpoints for individual components. *Components shown in the outline below in italics are those that ISAT felt strongly should be included, but were not included because a suitable source of data was not available, or if data were available they were not found to be in useable form.*

I. Value of salmonid populations in ecosystem to an ESU - Inclusive of each fish species and race: spring chinook, summer chinook, fall chinook, summer steelhead, winter steelhead, coho, summer chum, fall chum, odd-year pink, even-year pink, coastal cutthroat, sockeye, native char.

1. Need for conservation
   a. healthy stocks and ESUs not at-risk
   b. unhealthy stocks and ESUs at-risk
   c. stock origin
   d. production type of natural spawners (e.g., wild, composite, hatchery)
   e. genetic diversity

2. Fisheries management context
   a. overfished stocks
   b. spawner numbers
   c. hatchery fish identification
   d. natural production
   e. hatchery-natural ratio
   f. ecological interactions
   g. fish health management

II. Value of ecosystems to salmonids

1. Present ecosystem conditions
   a. estuary development
   b. nearshore marine condition
   c. forage fish
   d. percentage of urban development
   e. human population growth
   f. water quality
   g. percentage of land in agricultural use
   h. forest seral stage along streams
   i. channel gradient (related to fish productivity)
   j. impervious surfaces - road density
   k. hydrologic modification
   l. fish passage constraints

2. Water availability and distribution
   a. water availability for fish
   b. frequency of peak flows
   c. low flow limitations (ratio of minimum levels to natural variability)

3. Extent of intact ecosystem
   a. extent of protected lands (e.g., National Park or Wilderness Area lands).
   b. extent of stronghold areas
   c. aquatic biodiversity

Methods

ISAT used various information to describe the present and future conditions of salmonid populations and their ecosystems. Indices were identified for 10 salmonid and 14 ecosystem components.

ISAT's intent was to first consider the context of the coarse scale of the units being prioritized (WRIAs), and then identify information judged to be a reasonable match to that scale, in terms of the information type and detail. Because of the wide range of conditions and fish species/populations and their management circumstances within each WRIA, ISAT looked for general indices that could be expected to form reasonable surrogates of WRIA-specific ecosystem or salmonid population conditions. For example, the Elwha and Dungeness rivers are in the same WRIA but have very different factors affecting the health of wild salmonids present. One of these rivers (Elwha) contains two mainstem dams that totally block upstream migrations of anadromous salmonids, while the other does not; stocks in that river are faced with different limiting factors.

ISAT used several criteria in assessing and selecting information components. With few exceptions, information components used had to:

- provide general measures or indices of salmonid or ecosystem conditions,
- be available for all WRIAs in western Washington,
- be available from existing databases or scientific studies, and
- rely on data that, in ISAT's judgement, were of sufficient quality to meet the needs of the exercise.

All components were weighted equally. In other words, the total number of points possible for each salmonid or ecosystem component was the same. Although alternative weighting approaches are possible, ISAT felt this approach was the most appropriate and defensible at this time. To the extent that reliable scientifically-based alternatives can be developed they might be considered for inclusion in future iterations.

The weighting approach ISAT used in this iteration was not intended to suggest that all factors are likely to have the same level of influence on wild salmonids in all circumstances. Notably, the number of components differed within the salmonid (10) and ecosystem (14) categories. Thus, the ecosystem category had a greater influence on total scores, especially as related to existing relative conditions. Data were expressed in some cases as percentages or proportions to account for differences between WRIA size. In addition, in some cases, more than one component was associated with related issues. For example, multiple components relate to water, marine habitats, hatchery fish, and spawner numbers/stock status. Thus, ISAT did not intend to apply the constraint that only independent variables would be used.

Synthesis

ISAT organized all information from the salmonid population and ecosystem categories into a new X-Y coordinate system. This coordinate system, depicted conceptually in **Figure 4**, formed the foundation of the prioritization framework. The X and Y-axes each used information from the salmonid and ecosystem categories. This approach allows visual and quantitative representation of the relationships and variations among WRIAs. The two coordinates are:

1. *Y-axis*: the relative expected efficiency and benefits to wild salmonid populations for protection and restoration activities in a WRIA, and

2. *X-axis*: the relative existing condition of wild salmonids and their ecosystems within a WRIA (emphasis shifts from restoration to protection as the quality of existing conditions increases.)

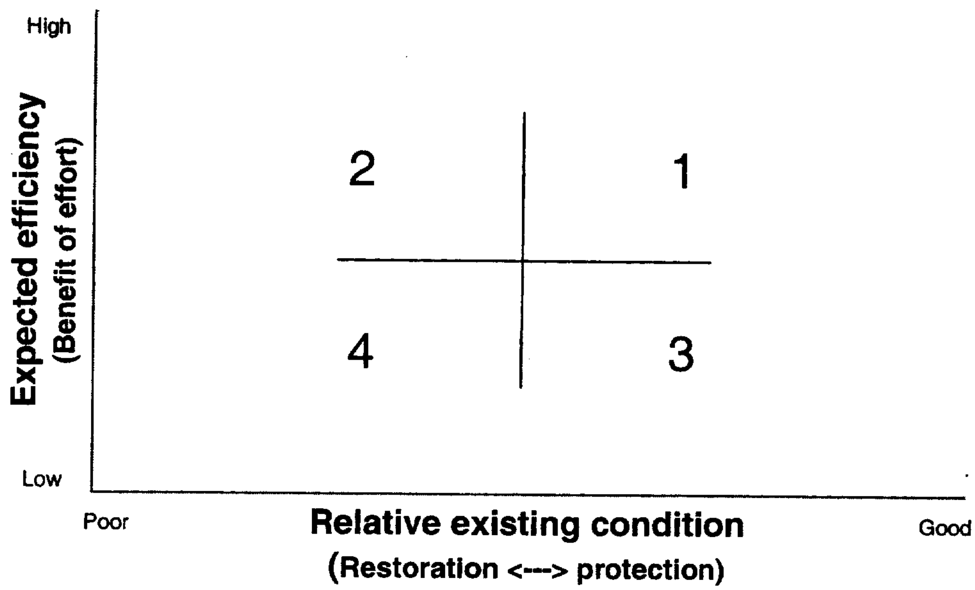

Figure 4. Conceptual diagram illustrating how composite scores for each WRIA were organized and related for visual interpretation.

Again, in **Figure 4** the Y-axis conceptually represents the relative expected efficiency and benefit of effort for recovery actions among WRIAs that would be expected to be needed to improve the general health of salmonid populations, regardless of the type of action (protection or restoration) undertaken. It does not address the needs of populations or species on an individual basis; it affords only a coarse, multispecies perspective. WRIAs that appear in the lower portions of the plot (lower Y-axis scores) would be expected to require the greatest effort for the return (lower benefit from efforts) relative to other WRIAs.

ISAT does not intend to suggest that recovery efforts would not be beneficial in WRIAs with low Y-axis scores. Low Y-axis scores simply mean that effective activities in those WRIAs would be expected to require more effort and would be expected to produce fewer benefits for similar levels of effort in comparison to WRIAs with higher Y-axis scores.

The X-axis represents the relative existing condition of salmonid stocks and their ecosystems. X-axis values are related to the expected need for restoration or protection emphasis for each WRIA. The further a WRIA is to the right on the graph (or the higher the X-axis score), the better the environment is within that WRIA and the more that efficient and effective benefits would be expected to accrue to wild salmonids through protection activities. In contrast, WRIAs with lesser quality/quantity habitat would be expected to fall to the left, and the benefits of recovery efforts in them would be expected to most efficiently and effectively emphasize restoration.

Conceptually, the distribution of WRIAs plotted on **Figure 4** can be interpreted in four quadrants or zones, although in practice the exact boundaries and position of these zones would require policy resolution. Placement of the partitions between zones must ultimately be based on policy goals, species/ESU recovery goals, implementation strategies, and other considerations. As shown conceptually in **Figure 4**:

- **Zone 1** would tend to include WRIAs that would have much to gain in terms of efficiency and benefit from conservation efforts, and in comparison to zone 2 would tend to favor protection activities.
- **Zone 2** would also have much to gain in terms of efficiency and benefit but since the starting conditions are poorer, those activities would be expected to entail more emphasis on restoration than protection.
- **Zone 3** would include WRIAs that are in relatively good condition initially, but relative to zones 1 and 2, efficiencies of activities would not be as high as in zones 1 and 2.
- **Zone 4** would contain WRIAs where efficiency is relatively low and initial conditions suggest that restoration is more likely to be more necessary and effective than protection.

One of the many challenges ISAT faced was determining what axis each component should be associated with. To address this each informational component was reviewed in detail to decide whether or not the measure best described the anticipated efficiency and benefits from efforts (Y-axis) or whether or not to relate its emphasis based on existing conditions to restoration or protection (X-axis). In many cases, the answers were clear, in others they were not. For example, in the salmonid category under the unhealthy and healthy stock information components, restoration was emphasized in WRIAs containing relatively large numbers of unhealthy stocks, whereas protection was emphasized in areas having relatively healthy stocks. Thus, information about the relative extent to which stocks within WRIAs were unhealthy (SASSI/ESA unhealthy status) was included as an X-axis variable. In contrast, protection and restoration actions are expected to be most successful at helping wild salmonid populations in the shortest possible time (efficient) where there are relatively large numbers of existing healthy stocks. Thus the informational component pertaining to stock diversity and health (SASSI/ESA healthy status) was included as a Y-axis variable. This illustrates how these two components are not simply opposites, but instead reflect the differences in the number of stocks weighted by their condition in the various WRIAs.

In terms of information in the salmonid ecosystem category, nearshore marine condition, urbanization, and stream gradient represent good examples of components addressing the relative benefits or effectiveness of efforts. These components reflect conditions that either once degraded, are essentially not likely to change substantially in the near term or are not subject to purposeful change at all (i.e., stream gradient). Ecosystem components such as these were included as Y-axis variables. In contrast, there were components used that were deemed much more subject to change or improvement as a result of deliberate management or conservation efforts. Examples of such components include agriculture, forest condition, and migration barriers at road culverts. Thus the emphasis of these components was on restoration or protection, and they were included as X-axis variables.

Available water provides an example of a salmonid ecosystem component that ISAT recognized could be included on either the X or Y-axis. ISAT's principle of emphasizing protection efforts where ecosystems/salmonids are healthiest would suggest that areas where water is available for salmonids should be protected and where it is inadequate, restoration efforts should be emphasized. However, ISAT also recognized that without adequate water flow, other habitat efforts will not be effective at producing benefits for wild salmonids. This would argue for including the measure of adequate water as a Y-axis variable.

ISAT felt that use of an X-Y coordinate system would provide a useful framework to identify WRIAs wherein recovery efforts would benefit the most salmonids to the greatest extent, in the shortest possible time.

Information resulting from this prioritization exercise were organized to allow use at three hierarchical spatial scales or different scales of interest, including:

- broad overview of WRIAs across all of western Washington,
- examination of characteristics and patterns between groups of WRIAs comprising the three salmon recovery regions in western Washington, and
- comparison of WRIAs within the ESA recovery regions.

A stepwise approach was used to identify priorities in western Washington. First, ISAT ranked WRIAs according to their respective combined Y-axis scores. This provided a ranked list of WRIAs indicating where the greatest benefits for wild salmonids might be expected for the least effort and in the shortest possible time. Second, the extent to which expected benefits might be associated with protection and/or restoration efforts was interpreted from the position of each WRIA along the X-axis. This was done by determining the Y-axis mid-line among the spread of WRIA points. Points falling to its left were identified as needing restoration emphasis whereas points to its right were identified as needing protection emphasis. Points close to the line were identified for both protection and restoration, indicated by a leading P or R depending on which the side of the line the point occurred.

Table 1. Informational components (from outline above) on X (existing relative condition) and Y (relative benefit or effectiveness) axes. *Components in italics were not included in this analysis, but are high priority needs for future iterations if suitable data are available for the study area. See Appendix 1 for a description of these components.*

Existing relative condition (X-axis)	**Relative benefit or effectiveness** (Y-axis)
Salmonid components	**Salmonid components**
Unhealthy stocks and ESUs at-risk	Healthy stocks and ESUs not at-risk
Genetic diversity	Stock origin
Spawner numbers	Production type of natural spawners
	Overfished stocks
Ecosystem components	Hatchery fish identification
Forage fish	Natural production
Human population growth	Hatchery-natural ratio
Water quality	*Ecological interactions*
Percentage of land in agricultural use	*Fish health management*
Forest seral stage along streams	
Impervious surfaces - road density	**Ecosystem components**
Fish passage - culverts	Estuary development
Water availability for fish	Nearshore marine condition
Extent of protected lands	Percentage of urban development
Salmonid strongholds	Channel gradient (productivity)
	Hydrologic modification (dams)
	Frequency of peak flows
	Low flow constraints
	Aquatic biodiversity

Results

The results of this prioritization exercise are geographically (WRIA) based, and identify both high and low priority WRIAs for recovery efforts. However, ISAT feels that all WRIAs in the study area should be recognized as containing valuable habitats and components of diverse salmonid species and life histories. Readers should guard against falsely concluding that some WRIAs are important while others are not. This ranking exercise merely provides guidance on how best to direct attention and emphasis among WRIAs at this point in time. As conditions change, results from a reanalysis would also be expected to change. To maintain and restore salmonids it will be important to recognize goals for recovery, and to integrate a geographical approach with a phased approach that deliberately distributes resources in time as well as geographically. Temporal considerations were not directly addressed in this framework. Recovery goals were not available.

As noted above, WRIA results were interpreted at three geographic scales: across western Washington, between salmon recovery regions, and WRIAs within regions.

Priority WRIAs across Western Washington

The quantitative results of this analysis are provided graphically and tabularly. **Figure 5** depicts the composite of scores for western Washington WRIAs plotted as X-Y coordinates. A summary table including information and scores for each component and data set is found in **Appendix 3**.

CAUTION: Due to the coarse nature of the methodology used to prioritize WRIAs, conclusions associated with relationships among WRIAs and their rankings should be interpreted with caution. Readers are strongly urged to consider the following (see also page 27):

1. ***The greater the distance between points of interest (WRIAs), the greater the confidence that actual differences exist, and***
2. ***As the distance between points of interest decreases, the likelihood of actual differences also decreases.***

Figure 5 depicts scores from each WRIA distributed along the X and Y-axes. Recall that the X-axis is a *relative* index of the existing salmonid and ecosystem conditions potentially affecting wild salmonids, and the Y-axis is a *relative* index of the relative efficiency or benefits to wild salmonids from a similar level of effort. WRIAs further to the right on the X-axis (e.g., Upper Skagit WRIA 4) have better initial conditions than do WRIAs to the left (e.g., Chambers-Clover WRIA 12). In general, a potentially useful way to look at the X-axis is to consider WRIAs further to the right as meriting protecting due to their relatively high quality/quantity conditions, and WRIAs to the left as having poorer conditions that may require more emphasis on restoration compared to protection. WRIAs higher on the Y-axis (e.g., Queets-Quinault WRIA 21) would be expected to

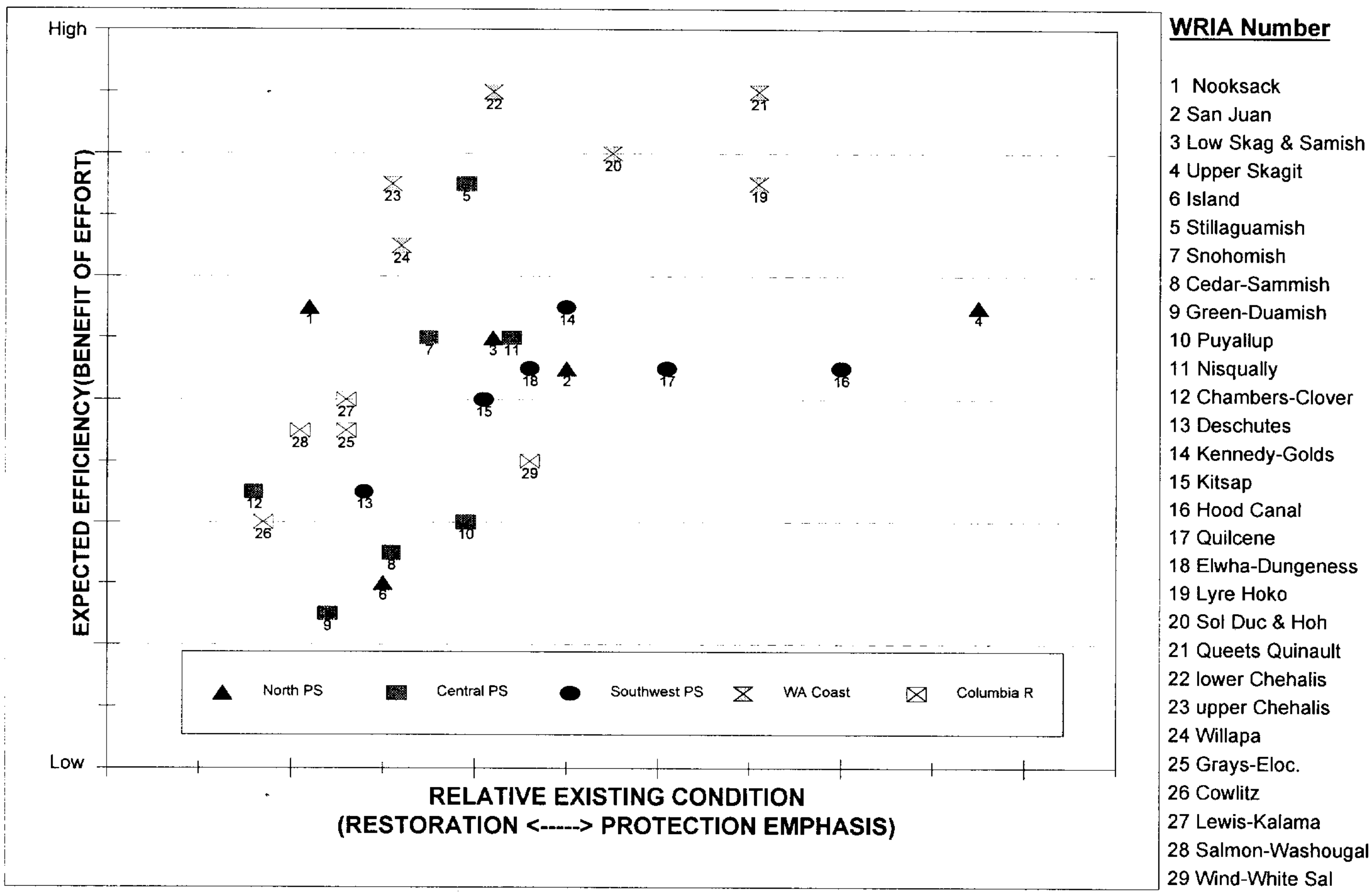

Figure 5. Composite scores for salmonid and ecosystem information for each WRIA in western Washington, showing relationships associated with the expected efficiency and benefits of recovery efforts (Y-axis) and the relative existing condition (protection and/or restoration emphasis)(X-axis).

benefit more from a given level of effort (expressed in fiscal or other currencies of effort) than WRIAs lower on the Y-axis (e.g., Green-Duwamish WRIA 9).

The distribution of points in **Figure 5** reflects the wide diversity of conditions and circumstances representing and affecting salmonids and their habitats among and within WRIAs in western Washington.

A ranked listing of WRIAs according to Y-axis scores (**Appendix 3**) is provided below in **Table 1**. Where Y-axis scores were the same, WRIAs were included in the same rank. The highest scores represent those WRIAs in which conservation and recovery efforts would be expected to have the greatest efficiency and benefit for salmonids in the shortest possible time. The table also includes a column indicating whether recovery efforts in each WRIA would be expected to emphasize protection or restoration activities. Protection or restoration emphasis is based on inspection of the X-axis in **Figure 5.**

When viewing X-axis scores of WRIAs across western Washington, **Figure 5** reveals that recovery efforts in the top tier (top 33% of WRIAs based on highest Y-axis scores), typically emphasize protection. When WRIAs in **Table 1** and **Figure 5** are viewed in three equal sized tiers or groups of WRIAs (about ten WRIAs each), viewed from top to bottom, the distribution WRIAs tends to move from protection to restoration emphasis.

<u>Patterns between regions</u>

To help identify patterns in the distribution of WRIA scores among regions, WRIAs in **Figure 5** are indicated by different symbols associated with each of the three different regions (Puget Sound, Washington Coast, Lower Columbia River). Inspection of this figure identifies general patterns among regions. A wider range of variation appeared to occur among the large number (WRIAs 1-18) of WRIAs in the Puget Sound region compared to WRIAs in other two regions. The second tier (33-66% of WRIAs) of Y-axis scores (**Table 1**) contained most Puget Sound WRIAs. Also, a large percentage (over 80%) of Puget Sound WRIAs were on the restoration (left) side along the X-axis. Most of the WRIAs having the highest quality environments and the most numerous stocks and diversity were located in the Washington Coastal (WRIAs 19-23) and Southwest Puget Sound regions (WRIAs 13-18), each in which emphasis in half of the WRIAs was on protection. In contrast, environments of the five WRIAs in the Lower Columbia River region (WRIAs 25-29) and the seven WRIAs in the Central Puget Sound (WRIAs 5, 7-12) were of lesser quality (lower X-axis scores). These WRIAs were generally found in the bottom of the second and in the third tier in **Table 1.** Compared to the other WRIAs in western Washington, the WRIAs essentially all had scores suggesting restoration should be emphasized. More detail is presented below on each region.

<u>Patterns within regions</u>

The interpretation presented above resulted from a broad view of WRIA information across western Washington. This section will explore patterns within each of the three major regions

(Puget Sound, Washington Coast, Lower Columbia River). It will also include a review of the three subregions in the Puget Sound region.

Table 1. Summary indicating the relative expected benefit and effectiveness of conservation actions for wild salmonids (combined Y-axis scores for all components) in the 29 western Washington. Protection (P) and/or restoration (R) were interpreted from Figure 5. Y-axis scores are from Appendix 3.

Rank	WRIA number/name	Y-axis score	Protection (P) and/or restoration (R) emphasis
1	21 Queets-Quinault	110	P
	22 Lower Chehalis	110	R
2	20 Sol Duc - Hoh	100	P/R
3	19 Lyre - Hoko	95	P
	5 Stillaguamish	95	R
	23 Upper Chehalis	95	R
4	24 Willapa	85	R
5	4 Upper Skagit	75	P
	14 Kennedy-Goldsborough	75	R/P
	1 Nooksack	75	R
6	11 Nisqually	70	R
	3 Lower Skagit-Samish	70	R
	7 Snohomish	70	R
7	16 Hood Canal	65	P
	17 Quilcene	65	P/R
	2 San Juan[4]	65	R/P
	18 Elwha-Dungeness	65	R/P
8	15 Kitsap	60	R
	27 Lewis-Kalama	60	R
9	25 Grays-Elochoman	55	R
	28 Salmon-Washougal	55	R
10	29 Wind-White Salmon	50	R/P
11	13 Deschutes	45	R
	12 Chambers-Clover	45	R
12	10 Puyallup	40	R
	26 Cowlitz	40	R
13	8 Cedar-Sammamish	35	R
14	6 Island[4]	30	R
15	9 Green-Duwamish	25	R

[4] These WRIAs are not home areas for salmonids of concern. The WRIAs were included however, because they are part of and can influence the larger ecosystem some salmonids use during the marine phases of their life cycles.

As cautioned previously, the greater the distance between points of interest, the greater the confidence that an actual difference occurred. As distances between points of interest decrease, the likelihood of actual differences also decreases. Readers should inspect variation in Y-axis scores at each scale of interest to ascertain the extent to which each point or group of points is different from the others within that scale.

Puget Sound

The Puget Sound region is comprised of the largest number of WRIAs (18) in western Washington (**Table 2**). For the purposes of this exercise, information was reviewed to discern general patterns within this broad region as well as those that may be apparent within its three "subregions" (North, Central, Southwest). *Note - ISAT recognizes subregional boundary delineations are not completely resolved. For present purposes the Puget Sound subregions were anchored by the Tri-County area, which includes Snohomish, King, and Pierce counties. That area was the Puget Sound Central subregion. Seven WRIAs were included in that subregion (WRIA# 5, 7, 8, 9, 10, 11, 12). In general, the areas north of Snohomish County and south of Pierce County were deemed to be the North (n = 5; WRIA# 1, 2, 3, 4, 6), and Southwest (n = 6; WRIA# 13, 14, 15, 16, 17, 18) subregions, respectively. The Upper Skagit and Stillaguamish WRIAs to the north, and the Nisqually WRIA to the south, share some of their watershed areas with the Central subregion.*

Review of Y-axis scores shows considerable variation (70) between WRIAs in Puget Sound. The top tier (top 33%) of Y-axis scores were primarily from the north and central parts of Puget Sound. With a few fairly clear exceptions (e.g., WRIAs 4, 16) benefits in most WRIAs in Puget Sound would be expected to accrue from an emphasis on restoration.

Based on the distribution of Y-axis scores, WRIA 5 (Stillaguamish) appears to stand out as the highest priority WRIA in Puget Sound in terms of expected efficiency and benefit of recovery actions. **Table 2** suggests a restoration emphasis in over 80% of the WRIAs in the Puget Sound region.

Within Puget Sound subregions

As shown in **Figure 3** and **Table 3**, the range of variation in Y-axis scores for WRIAs in North Puget Sound was intermediate (45) to that of the Central (70) and Southwest (30) subregions. As noted earlier, WRIA 5 (Stillaguamish) is fairly well separated from the other WRIAs in the Central subregion, and is quite distinct from WRIAs 8 and 9 (Cedar-Sammamish and Green-Duwamish, respectively). Variation among WRIAs within the Southwest subregion was relatively small, with WRIA 13 (Deschutes) being most clearly distinguishable from the other WRIAs in that subregion.

Table 2. Summary indicating the relative expected benefit and effectiveness of conservation actions for wild salmonids (combined Y-axis scores for all components) in the 18 WRIAs in the Puget Sound region. Information on rank, Y-axis scores, and protection (P) and/or restoration (R) emphasis is from Table 1.

Rank	WRIA number/name	Y-axis score	Protection (P) and/or restoration (R) emphasis
1	5 Stillaguamish	95	R
2	4 Upper Skagit	75	P
	14 Kennedy-Goldsborough	75	R/P
	1 Nooksack	75	R
3	11 Nisqually	70	R
	3 Lower Skagit-Samish	70	R
	7 Snohomish	70	R
4	16 Hood Canal	65	P
	17 Quilcene	65	P/R
	2 San Juan	65	R/P
	18 Elwha-Dungeness	65	R/P
5	15 Kitsap	60	R
6	13 Deschutes	45	R
	12 Chambers-Clover	45	R
7	10 Puyallup	40	R
8	8 Cedar-Sammamish	35	R
9	6 Island	30	R
10	9 Green-Duwamish	25	R

Table 3. Summary of the three Puget Sound subregions indicating the relative expected benefit and effectiveness of conservation actions for wild salmonids (combined Y-axis scores for all components). Information on rank, protection (P) and/or restoration (R) emphasis is from Table 1.

North			Central			Southwest		
WRIA#	Y-axis	P-R	WRIA#	Y-axis	P-R	WRIA#	Y-axis	P-R
1 Nooksack	75	R	5 Stillaguamish	95	R	14 Kennedy-Golds.	75	R/P
4 Upper Skagit	75	P	11Nisqually	70	R	16 Hood Canal	65	R/P
3 Lower Skag.-Sam.	70	P	7 Snohomish	70	R	17 Quilcene	65	P/R
2 San Juan	65	R/P	12 Chambers-Clover	45	R	18 Elwha-Dungeness	65	P
6 Island	30	R	10 Puyallup	40	R	15 Kitsap	60	R
			8 Cedar-Sammamish	35	R	13 Deschutes	45	R
			9 Green-Duwamish	25	R			

Washington Coast

Compared to other regions in western Washington, variation among Y-axis scores within the Coastal region was relatively small (25), indicating a relative similarity among salmonid and ecosystem features within this region. As noted previously, compared to other regions, WRIAs in the Coastal region generally contain salmonid populations and habitats with fairly good existing conditions. In addition, recovery actions might be expected to have the greatest benefit for salmonids with the least effort, in the shortest possible time in these WRIAs. An emphasis on protection is indicated in half of the WRIAs. WRIAs in this region tended to contain more high Y-axis scores than any other in western Washington.

Table 4. Summary indicating the relative expected benefit and effectiveness of conservation actions for wild salmonids (based on combined Y-axis scores for all components) in the 6 WRIAs in the Washington Coast region. Information on rank, Y-axis scores, and protection (P) and/or restoration (R) emphasis is from Table 1.

Rank	WRIA number/name	Y-axis score	Protection (P) and/or restoration (R) emphasis
1	21 Queets-Quinault	110	P
	22 Lower Chehalis	110	R
2	20 Sol Duc-Hoh	100	P/R
3	19 Lyre-Hoko	95	P
	23 Upper Chehalis	95	R
4	24 Willapa	85	R

Lower Columbia River

Y-axis scores between WRIAs within the Lower Columbia region varied the least (20) of any region in western Washington, reflecting a general similarity of the salmonid and ecosystem features within this region. In addition, the highest Y-axis scores for WRIAs in this region were lower than those for other regions, suggesting that the efficiencies and benefits from recovery actions generally might be less in this region compared to the others. Put another way, more effort/resources will be needed to achieve a similar level of recovery. An emphasis on restoration was noted for all WRIAs the Lower Columbia region, with the possible exception of WRIA 29 (Wind-White Salmon) in which relative protection emphasis was greatest.

Table 5. Summary indicating the relative expected benefit and effectiveness of conservation actions for wild salmonids (based on combined Y-axis scores from all components) in the 5 WRIAs in the Lower Columbia region. Information on rank, Y-axis scores, and protection (P) and/or restoration (R) is from Table 1.

Rank	WRIA number/name	Y-axis score	Protection (P) and/or restoration (R) emphasis
1	27 Lewis-Kalama	60	R
2	25 Grays-Elochoman	55	R
	28 Salmon-Washougal	55	R
3	29 Wind-White Salmon	50	R/P
4	26 Cowlitz	40	R

Summary and Recommendations

A cautionary reminder

The prioritization framework and analysis provided here are intended to extend the scientific underpinnings of the initial effort outlined in the Draft Statewide Salmon Recovery Strategy, with emphasis on recovery efforts aimed toward improving habitat for wild salmonids in western Washington. The results of this exercise are geographically based (WRIA), and identify a range of priority WRIAs for recovery efforts. All results comparing WRIAs against each other should be considered in relative terms. There are no absolutes.

The system described here illustrates one approach, but others are possible, depending on policy overlays, alternative analytical and weighting schemes, and use of information that was unavailable to ISAT.

As stated previously, ISAT feels strongly that all WRIAs in the study area should be recognized as containing valuable habitats and components of salmonid species and life history diversity. While some habitats may be of only marginal quality, such habitats can be important for the full expression of life history diversity and productivity in salmonid species. It is risky to assume that some WRIAs are valuable while others are not. This ranking exercise merely provides guidance on where protection and restoration attention and emphasis might be directed among WRIAs at this point in time. To protect and restore salmonids efficiently and effectively it will be important to have clear recovery goals and objectives for species/ESUs and habitats, and to integrate geographical approaches with plans that deliberately distribute resources in time as well as in space (e.g., within and across project sites, watersheds, regions).

Summary comments

The prioritization framework presented here was developed to meet a specific assignment from the Joint Natural Resources Cabinet. This framework extends that provided in the draft Statewide Salmon Recovery Strategy by bolstering incorporation of scientific principles and including additional information categories and components.

Given the caveats previously noted, this framework leads ISAT to offer the following generalizations about expected efficiencies, effectiveness, and types of efforts that might be undertaken in western Washington:

- Recovery efforts directed at the Coastal region (19-24), and Stillaguamish (5) WRIAs would generally be expected to produce the greatest efficiency and benefits to wild salmonids.

- In contrast, the efficiency and benefit of recovery efforts directed at WRIAs 9 (Green-Duwamish), 8 (Cedar-Sammamish), 10 (Puyallup), 26 (Cowlitz) would be expected to be lowest. (Note WRIA 6-Island is also included in this group but has relatively limited influence on salmonid and ecosystem values.)

- There are few WRIAs with relatively good existing conditions, whose benefits from recovery efforts would be expected to accrue from an emphasis on protection. These few include WRIA 4 (Upper Skagit), 16 (Hood Canal), 19 (Lyre-Hoko), and 21 (Queets-Quinault).

- In contrast, there are many WRIAs with poorer conditions in which the most beneficial results from recovery efforts would accrue from an emphasis on restoration. Importantly however, in less than half of these WRIAs would efficiency and benefits be expected to be high relative to other WRIAs. WRIAs in which efficiencies and benefits from an emphasis on restoration would be expected to be highest include WRIA 3 (Lower Skagit-Samish), 11 (Nisqually), 7 (Snohomish), 1 (Nooksack), and 14 (Kennedy-Goldsborough).

How to interpret this information

Summary tables and figures are provided that characterize the relative priority of WRIAs at multiple spatial scales of potential interest to meet the general goals of efficiency and effectiveness. It is important to reiterate that these goals DO NOT represent specific responses to listings or proposed listings under the ESA.

The Y-axis represents the sum of factors that ISAT used to depict the anticipated response of wild salmonids to protection and restoration efforts. Based on the ecosystem condition of WRIAs and the health and diversity of salmonid populations within them, ISAT expects different levels of salmonid response will occur from a given level of conservation effort.

A general approach for use of these tables to identify specific priority WRIAs in a coarse manner would be to:

1. view those WRIAs with the highest Y-axis scores as being in the highest priority tier. WRIAs in that tier might be expected to produce the greatest efficiencies and expected benefits to wild salmonids in the shortest possible time, and then
2. inspect the associated tables and figures to ascertain whether that WRIA might best receive protection and/or restoration emphasis.

Another way to view the Y-axis is that to achieve a similar level of recovery, much more effort will be required in those WRIAs with low Y-axis scores. Availability of technical and policy goals pertaining to how much recovery is desired, in what areas, and over what time frames, should help determine whether a "triage" approach is needed. It was not ISAT's intent for readers to interpret the Y-axis scores merely as recommendations related to the amount of money or other resources that should be spent among WRIAs, or that recovery efforts are not needed in some WRIAs (e.g., triage, because either they are not worth the effort or effort would be relatively unproductive compared to other areas [low Y-axis score]; or they do not need recovery attention [high Y-axis score]). Those judgements must await technical and policy responses once specific species/ESU recovery goals are available.

Until policy and recovery goals are better clarified, it will likely be argued that most fiscal or other effort should be directed to one of two alternatives. One is that effort should be directed to WRIAs with low Y-axis scores to get them up to a certain base level of recovery; the other is to put most of the available resources into WRIAs with high Y-axis scores where the most efficient and immediate responses would be expected (i.e., triage). Again, sorting among these options will be most meaningful once clearly articulated recovery goals are available. ISAT generally expects that a diversity of healthy salmonid populations will be needed for recovery of salmonids within regions. The purpose of the Y-axis is to indicate the variability in expected responses so that reasonable policy and management decisions and expectations can be pursued.

It is important to distinguish between this scientific framework and the policy and management decisions that remain to be made to use the information in prioritizing actions. ISAT's work provides technical information supportive to decisions associated with policy priorities for recovery activities and expenditures. It is not ISAT's charge to make those decisions. Decision makers must contend with how to resolve species and policy goals, risks, and other social, economic, and other considerations. It is hard to imagine that resources will ever be sufficient to address all the needs that exist in all WRIAs. Hard allocation decisions appear inevitable.

Again, ISAT understand determination of allocation thresholds is a policy and administrative issue, not a scientific one. The draft SSRS outlined an allocation scheme whereby 20% of the available resources would be distributed broadly across all WRIAs, and of the remaining 80%, 60% would be allocated to protection and 40% would be allocated to restoration. The results of ISAT's prioritization scheme could be used to provide guidance within those or other allocation parameters.

Implementation context

ISAT developed this prioritization framework by identifying and using only information on salmonids and their ecosystems that met stated criteria for inclusion. In addition to that information however, ISAT strongly advises that another category of information - **implementation context** - be used to make prioritization decisions. This could be one of the key policy overlays imposed on the available scientific information.

ISAT felt the extent to which commitments to salmonid and ecosystem resources are actively demonstrated and ready to proceed should be assessed for each WRIA. WRIAs that have functional planning and implementation management structures and processes that are more advanced and coordinated in addressing all factors affecting production, would be expected to have the best chance of contributing the most immediate and substantial benefits from new habitat protection and/or restoration efforts, all else being equal.

ISAT identified overarching concerns and assumptions that could be addressed in considering implementation of a prioritization system, including:

- human population growth will occur at a rapid pace into the future,
- given the increase in human population pressure, human behavior and institutional mechanisms will lead to sufficient numbers of spawning fish to support human needs and ecosystem functions, and
- focused and organized strategies and plans will provide reasonable and successful recovery approaches.

It is not clear whether these assumptions will prove correct, but their implications should be considered if recovery if populations of salmonids are to viable and sustainable over the long term.

ISAT recommends that a complementary scoring system be developed as a final filter of ISAT's prioritization output at the desired WRIA/regional scale(s) of interest. Assessments of adequacy or extent could be made for the list below, whether effectively planned (e.g., receiving some level of positive score) or implemented (e.g., receiving higher positive scores), and integrated across the multiple jurisdictions operating within salmonid ecosystems (e.g., local, state, federal). The following types of information might be used:

- Existence of functional watershed and regional scale conservation/recovery governance structure(s).
- Projections of human population growth and related demands on watersheds.
- Occurrence and degree of completion/implementation of species/comprehensive conservation or recovery plans, HCPs, landscape plans, watershed management plans, etc.
- Adequacy of fish-friendly dam/hydro operations.
- Provision of instream flows at the right times and in the right places.
- Extent of fish passage improvement plans and implementation (small and large obstructions).
- Adequacy of growth management plans and compliance (e.g., shorelines management plans, stormwater ordinances, critical areas).
- Adequacy of fishery harvest management plans/agreements exist that meet human as well as ecosystem needs.
- Adequacy of hatchery management reforms to address risks while achieving benefits.
- Adequacy of agricultural plans/practices.
- Adequacy of forest practices.
- Adequacy of information/data on watershed condition (structure, function, dynamics)
- Existence of functional monitoring, evaluation, data collection, and adaptive management frameworks.

Final comments about protection vs. restoration

ISAT does not feel that each WRIA should be strictly considered for either protection or restoration since a wide range of conditions and circumstances exist within each WRIA. Within each WRIA it is highly likely that protection and restoration needs will be identified. Analyses and assessments of conditions within watersheds and for individual salmonid species and stocks will have the greatest power in directing resources to restoration and/or protection activities within WRIAs. However, the framework provided here reflects a coarse, multispecies, and timely approach that should help guide the type and extent of effort and/or resources to activities on the ground.

Scientific principles call for emphasis on conservation and restoration of habitat structure (e.g., native diversity of ecosystems), function (e.g., ecosystem productivity, hydrology, trophic structure, and transport)(Williams et al. 1997), and habitat-forming processes (Beechie and Bolton 1999). The emphasis of efficient and effective conservation and recovery efforts should address the causes of degradation, not the symptoms.

The objective of this exercise was not just to identify the WRIAs in which efforts would be expected to be most efficient and beneficial, but to attempt to distinguish among WRIAs whose efficient benefits would be achieved from protection or restoration emphasis. The identification of areas for protection emphasis is a fundamental part of conservation and recovery planning strategies for many species. Protection emphasis can be manifested in many ways. For example, protection designations can be formalized from designation and focused management of critical areas (e.g., via WDFW Priority Habitats and Species; Growth Management Act), riparian reserves (e.g., CREP, Northwest Forest Plan Aquatic Conservation Strategy (FEMAT 1993)), "key watersheds" (e.g., Northwest Forest Plan (FEMAT 1993)), fish refugia or sanctuaries (e.g., Sedell et al. 1990; Moyle and Yoshiyama 1994; Li et al. 1995; Rahr et al. 1998), and enforcement emphasis complementary to all of the above. Many other examples could be identified to help illustrate strategies geared toward protection.

However, it is important to stress that the distinction between protection and restoration emphasis is relative. It would be hard to find a watershed or ecosystem in western Washington that has not been affected to some extent by human activities. Thus, complementary restoration of ecosystem structure and function may indeed need to be considered in WRIAs where protection is emphasized, and it will be imperative to protect features and investments once restored if positive results are to be sustained over the long term. Moreover, within WRIAs in which restoration emphasis was identified (i.e., relatively poor existing conditions), it is likely that there are areas or pockets of high quality habitat for which protection strategies would be expected to provide efficient and effective benefits, if pursued in an ecosystem context.

Suggestions for future iterations

While ISAT feels this prioritization system and analysis represent substantial improvement over the methodology outlined in the draft SSRS, additional improvements can always be identified. Various enhancements could be performed to improve the approach in subsequent iterations. Suggestions for future iterative improvements should be targeted on the data and/or analysis needs expected to have the greatest impact on meeting stated objectives. At this time ISAT suggests the following priority enhancements to this process (not in priority order):

- A fundamental need exists to better define and incorporate recovery goals regarding desired future conditions for wild salmonid populations and their habitats at appropriate spatiotemporal scales. Such information will allow a much improved and focused prioritization scheme.

- Develop and utilize a GIS-based approach and tools (e.g., Lunetta et al. (1997)).
- Identify/incorporate new data (e.g., ecological interactions/fish health; hydrograph/low info; strongholds; aquatic biodiversity metrics).
- Consider more explicit means to express and incorporate capacity for improvement in habitat and wild salmonid status.
- Improve/update databases used (e.g., SASSI/SaSI; human population growth) to reduce or eliminate data gaps.
- Review alternative scoring/weighting schemes (current emphasis on ecosystem components).
- Develop adequate information to perform analyses at finer scales of resolution (e.g., Watershed Administrative Units (WAUs)) rather than WRIAs.

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Appendix 1

Explanation of information sources, data, and scoring systems

I. VALUE OF SALMONID POPULATIONS IN ECOSYSTEM TO ESU

I.1. Need for conservation (condition of stocks in WRIAs)

I.1.a. *Healthy stocks and ESUs not at-risk*

Importance of the healthy stocks and ESUs component: The expected benefits of maintaining healthy stocks through properly functioning ecosystems and sound fish management depend on three basic factors: underlying ecosystem productivity, stock diversity, and the condition of the habitat. ISAT used the measure of healthy stocks as one of the indicators of the overall benefit of conservation actions (both protection and restoration). Basic information on stock status and ESA listing status is essential to understand the extent and distribution of the most healthy stocks among WRIAs. Just as there are different geological processes that formed and maintain stream characteristics (e.g., glacial runoff vs. rainfall), different WRIAs contain streams that vary in the complexity of salmonid stock structure. ISAT expects the greatest benefits to Washington's salmonids from conservation efforts will be in WRIAs where the stock diversity and health are the greatest.

Data source: Data on stock status were obtained from the 1993 Salmon and Steelhead Stock Inventory (SASSI) (WDF et al. 1993) and 1998 Bull Trout/Dolly Varden Salmonid Stock Inventory (SaSI) (WDFW 1998). Preliminary stock status updates were provided by WDFW where possible. ESA listing status information was also used to rank each WRIA. In addition to information on formal or proposed listing status, where ESA stock status reviews are still ongoing, scores were used based on WDFW's assessment of potential for listing. Attachment 2 of the SSRS presents this information in tabular format.

Limitations: The data used to identify healthy stocks of salmon and steelhead is somewhat outdated (WDF et al. 1993). WDFW is planning to update this information soon.

Scoring: Healthy stock and ESA status scores were plotted on the potential effectiveness (Y) axis. Individual scores in Attachment 2 of the SSRS were assigned as in the table below. Summary scores were developed for each WRIA. Ranked totals were essentially rated on a curve. Based on the top score the 66th and 33rd percentiles were determined. A score of 57/87 = 66% and a score of 29/87 = 33% (100-66%=10, 65-33%=5, 33-0%=-0). These scores are not the opposite of unhealthy stocks and ESUs at-risk because of the different numbers of total stocks in WRIAs.

Healthy stocks and ESUs			
SASSI/SaSI		ESA	
Healthy	3	Not warranted	3
Depressed	0	Candidate	0
Critical	0	Threatened	0
Unknown	0.5	Endangered	0

I.1.b. *Unhealthy stocks and ESUs at-risk*

Importance of the unhealthy stock and ESUs component: Focusing habitat restoration actions where there are at-risk stocks are important recovery tools. Basic information on stock status and ESA listing status is essential to understand the extent and distribution of unhealthy stocks within and among WRIAs.

Data source: Data on stock status were obtained from the 1993 Salmon and Steelhead Stock Inventory (SASSI) (WDF et al. 1993) and 1998 Bull Trout/Dolly Varden Salmonid Stock Inventory (SaSI) (WDFW 1998). Preliminary stock status updates were provided by WDFW where possible. ESA listing information was also used to rank each WRIA. In addition to information on formal or proposed listing status, where ESA stock status reviews are still ongoing, scores were used based on WDFW's assessment of potential for listing. Attachment 3 of the SSRS presents this information in tabular format.

Limitations: The data used in to identify unhealthy salmon and steelhead stocks are somewhat outdated (WDF et al. 1993). WDFW expects to update this information for use in the future.

Scoring: Unhealthy stock and ESU scores were plotted on the relative condition (X) axis to emphasize restoration activities for those WRIAs with large numbers of unhealthy stocks and protection actions for those WRIAs with the least numbers of unhealthy stocks. Individual scores in Attachment 3 of the SSRS were assigned as in the table below. Summary scores were developed for each WRIA. Ranked totals were essentially graded on a curve. Based on the top score the 66th and 33rd percentiles were determined. A score of 25/37 was used at the 66% cutoff and 12/37 was used as the 33% cutoff (100-66%=0, 65-33%=5, 33-0%=10).

Unhealthy stocks and ESUs			
SASSI/SaSI		ESA	
Healthy	**0**	**Not warranted**	**0**
Depressed	**2**	**Candidate**	**1**

Critical	**3**	**Threatened**	**2**
Unknown	**0.5**	**Endangered**	**3**

I.1.c. *Stock origin*

Importance of the stock origin component: The naturally spawning salmonids in Washington streams can have different origins due to past and present fish management practices. Many streams contain stocks that are native to that stream Other stocks are comprised primarily of an interbreeding mixture of native and fish from other watersheds, and in some locations, a stock has become established outside of its original range (by completely displacing the native stock or starting a natural population where the species did not exist historically). Physical marks, coded-wire tag recoveries, hatchery planting records, migration barrier removals, and genetic investigations were used to identify the origin of stocks in each WRIA. ISAT expects greater benefits to Washington salmonids from habitat conservation actions (both protection and restoration) will occur where there are the greatest numbers of native stocks. The WFWC's Wild Salmonid Policy (WSP) also prioritized native fish over mixed and localized nonnative fish.

Data source: Data for stock origin of seven species types were taken from WDF et al. (1993).

Limitations: An update of SASSI is needed and this should more broadly distribute the scores.

Scoring: The number of stocks for each stock origin category by WRIA was totaled. A few stocks overlapped WRIAs (e.g., Samish/MS Nooksack fall chinook counted for both WRIA 1 & 3). The number of native origin stocks in each WRIA received a multiplier of 5, the number of mixed-origin stocks 1, and the number of nonnative origin stocks, -5 (unknown and unresolved stocks were given a value of 0). Non-native in SASSI refers to the individual basin, not the state. The stock origin value for each WRIA was the sum of the native, mixed and nonnative scores. This stock origin score was divided by the total possible score (the number of stocks X 5) for that WRIA to get the scaled percentage (100-66%=10, 65-33%=5, 33-0%=0). Scores for stock origin were put on the potential effectiveness axis (Y) to prioritize native, wild spawning stocks.

I.1.d. *Production type of natural spawners*

Importance of the production type component: The subjects of the ESA are "natural fish" in determining the health and recovery of ESUs. Natural fish are those which came from parents that spawned naturally in the wild (sometimes referred to as natural origin recruits). The Washington Fish and Wildlife Commission's WSP uses this same definition for wild fish. The reason for this distinction is that information is not typically available to identify the hatchery or wild ancestry of fish on an individual basis once they have been born in the wild. The WSP prioritizes native fish over localized nonnative fish and limits the number of hatchery-origin fish that spawn in the wild (except for formal supplementation programs).

Data source: Data for production (spawner) type for the seven species were taken from SASSI (1993).

Limitations: An update of SASSI is needed and planned by WDFW; ISAT expects use of that revised information would likely broaden the distribution of scores.

Scoring: The number of stocks for each spawner type was totaled by WRIA. A few stocks overlapped WRIAs (e.g., Samish/MS Nooksack fall chinook counted for both WRIA 1 and 3). Multipliers for different types were: wild = 5, composite = 1, and cultured = -5 (unknown and unresolved were given a value of 0). The value for each WRIA was the sum of the native, mixed and nonnative scores. This score was divided by the total possible score (the number of stocks times 5) to get the scaled percentage (100-66%=10, 65-33%=5, 33-0%=0). Scores for spawner type were put on the potential effectiveness axis (Y) to prioritize native, wild spawning stocks.

I.1.e. *Genetic diversity*

Importance of the genetic diversity component: Knowledge of genetic diversity is fundamental to the protection and recovery of salmonid species. The genetic diversity information in this category summarizes important core population genetic types within and among the salmonid species in Washington. These are groups which represent genetic attributes (as identified primarily by allelic data from allozymes) that are not found to a substantial degree in other WRIAs or streams. Genetic differences are not always large enough to identify the group as an ESU, but it still represents an important component of the genetic diversity of the species in Washington.

Data source: The NMFS coastwide stock status reviews produced for ESA deliberations and WDFW's documents describing genetic diversity units (e.g., WDFW 1995) were used to develop scores for each WRIA.

Limitations: It is difficult to generalize genetic diversity given the multitude of salmonid species in each WRIA. The WRIA scores for this category did not differ much.

Scoring: A score of 5 indicated that the WRIA contained two or more distinct genetic stocks that in ISAT's opinion represented an important part of the diversity for that species in Washington. A score of 3 indicated that at least one of the populations in the WRIA was an important component of the species. All WRIAs had at least one stock important for stock diversity except San Juan and Island (WRIAs 2 and 6). Stock diversity information was plotted the relative condition (X) axis to identify WRIAs with large numbers of genetic diversity core populations (for protection) and to identify WRIAs with low salmonid genetic diversity for restoration.

I.2. Fisheries management context

I.2.a. *Overfished stocks*

Importance of the overfished stocks component: Prioritization of efforts to protect and/or restore habitats must include information on the extent to which harvest management provides sufficient spawners to spawning areas. Overfished stocks are those wild stocks that were intentionally harvested at rates that cannot be sustained by natural production so that intermixed hatchery fish could be harvested at the higher rate. The expected benefits from habitat restoration and protection efforts depend on the ability of the stocks in the watershed to respond. An insufficient number of spawners due to fisheries will likely hamper recovery.

Data source: For each WRIA, information on the number of salmon stocks over fished was taken from those listed in the Wild Salmonid Policy FEIS (Table II-1, page 9). No changes were assumed when SASSI stocks did not match exactly (i.e., the number of stocks of a species in SASSI did not agree perfectly with the number in Table II-1).

Limitations: As is the case in general with SASSI, this information may not be fully current.

Scoring: For each WRIA, the number of over fished salmon stocks was divided by the total number of salmon stocks (excluding steelhead stocks) to obtain the percentage over fished. Point scores were assigned to groupings as follows: 100-66%=10, 65-33%=5, 33-0%=0. These values were plotted on the relative effectiveness (Y) axis because restoration and protection efforts will not be successful if the number of natural wild spawners is insufficient to take advantage of the improved habitat conditions.

I.2.b. *Spawner numbers*

Importance of the spawner numbers component: Spawner numbers are values representing the proportion of the stocks of a species for each WRIA that meet or exceed their escapement goal on a consistent basis. The difference between this component and the stocks Overfished component is that this measure also includes both habitat conditions and non-directed harvest and is based on escapement goals for Pacific salmon. Even where fish management activities allow adequate numbers of wild fish to spawn naturally, some areas do not achieve goals for spawner escapement because of changes in habitat conditions and bycatch.

Data source: Data were from Pacific Fisheries Management Council annual reports and WDFW unpublished.

Limitations: The accuracy of spawner numbers varies due to the assessment method, species and stream conditions. For example, weirs give a count of fish moving upstream, but are not widely used due to cost and stream size. Spawning ground surveys are better for mainstem spawners such as chum and pink salmon. The accuracy of redd counts depends on stream conditions such as glacial water sources and patterns of annual runoff). This information is more current than SASSI and is based on "escapement" estimates (which were only one component of the stock status rating in SASSI).

Scoring: For each WRIA, a score of 10 indicates that the escapement goal for most stocks of a species is met, a score of 5 indicates that around half of the stocks of a species meet their escapement goals, and a score of 0 indicates that most of the stocks of a species do not meet their escapement goals on a consistent basis. Scores were plotted on the relative condition (X) axis so that salmon and steelhead areas that are achieving their escapement goals will receive protection, and restoration will be emphasized where these species do not meet those levels.

I.2.c. *Hatchery fish identification*

Importance of the hatchery fish component: Releases of hatchery fish are known to pose both genetic and ecological risks to wild salmonids. This category refers to the implemented ability to effectively distinguish those fish released from hatcheries from those that were naturally produced. This prioritization factor is used to identify WRIAs where an assessment of the type of fish spawning naturally is possible. Identification of hatchery or wild origin is very useful for monitoring the effects of restoration or protection efforts, especially in the context of genetic and ecological interactions.

Data source: WDFW data. Both internal marks and tags (e.g., coded-wire tags, PIT tags, otolith and genetic marks and tags), and external marks (excised fins) were used for this category.

Limitations: Fish marking and monitoring procedures and processes are in a state of rapid change.

Scoring: Scores were developed for each WRIA. A score of 10 indicates that hatchery fish for most of the species can be identified, 5 indicates some of the species (coho and steelhead and maybe chinook), and 0 denotes situations where only a few of the species if any can be differentiated. Hatchery fish scores were plotted on the relative effectiveness (Y) axis to emphasize WRIAs where the best understanding exists regarding associated factors affecting natural production.

I.2.d. *Natural production*

Importance of the natural production component: Knowledge of freshwater production is important for distinguishing between the relative influences of freshwater and marine survival on salmonid abundance (because both can vary by an order of magnitude). This natural production component reflects the level of understanding about the numbers of wild salmonids produced in WRIAs and the factors that influence that production. Restoration and protection efforts can affect freshwater and near-shore marine areas, but not marine productivity. The expected benefits of restoration and protection actions will likely be more effective where a database exists and where an assessment of natural production is possible.

Data source: StreamNet database; WDFW unpublished data.

Limitations: The methods and effectiveness of natural production monitoring varies by species and watershed characteristics.

Scoring: For each WRIA scores were assigned according to the following: existing long-term juvenile and adult counts/weir databases = 10 (favorable), WRIAs having recent and candidate evaluations = 5 (medium), minimal natural production evaluation effort = 0 (unfavorable). Natural production scores were plotted on the relative effectiveness (Y) axis to emphasize WRIAs where there is the best understanding of factors affecting natural freshwater production.

I.2.e. *Hatchery-natural ratio*

Importance of the hatchery-natural ratio component: The hatchery-natural ratio is the number of hatchery fish released in a WRIA compared to the estimated number of naturally produced salmonids. This component is a reasonable surrogate for ecological interactions risk. ISAT only considered the hatchery:natural ratios of each species and did not include specific efforts to address or minimize ecological interactions risks. ISAT also did not attempt to account for risks of interspecific ecological interactions. Both of these components are to be included in future iterations. The expected response of wild salmonids from habitat protection and restoration actions will be most effective where cultured production is minor compared to the abundance of naturally produced salmonids.

Data source: ISAT used four primary sources as a basis for the prioritization scores: (1) for coho and chinook salmon, the 1998 Pacific Salmon Treaty preseason report I, Stock Abundance Analysis (estimated adults) for 1998 Ocean Salmon Fisheries, prepared by the salmon technical team, Pacific Fisheries Management Council, Portland; (2) NMFS species status reviews; (3) WDFW hatchery operation plans and performance summaries; and (4) WDFW natural production estimates. Four species - chinook, coho, chum, and steelhead, were included in this component.

Limitations: High quality estimates of natural production are generally limited. WRIA 15 (Kitsap) is a good example of the diversity of conditions that occur within a WRIA. For coho, the Puget Sound portion (that portion in the Central Puget Sound subregion) of the WRIA contains almost all hatchery production, but its Hood Canal portion (that portion in the Southwest Puget Sound subregion) is almost all natural coho production.

Scoring: If the estimated hatchery production was two times the natural production for a species, that species received a score of 0. If the natural and hatchery production was approximately equal, ISAT a score of 5 was assigned. If natural production was two times the cultured production, 10 points were assigned. The scores were averaged (total score divided by four (except where one species did not occur - like chum in lake Washington where the total score was divided by three)). Even though the ratio of hatchery to naturally produced salmonids changes annually, the three groupings ISAT used for this measure appeared to be fairly stable over time. This component was placed on the Y-axis because the anticipated benefits to wild salmonids will be the greatest in WRIAs where they comprise the majority of the production.

I.2.f. *Ecological interactions*

Importance of the ecological interactions component: Fishery management activities have the potential to create situations where ecological risks are imposed on wild stocks as a result of efforts targeting other species. For example, risks to wild salmonids can occur from competition and predation by other artificially propagated salmonids, or by non-salmonid warmwater exotic species. In addition, recovery efforts targeting a species have the potential to adversely impact another at-risk or other species. Reconciling significant conflicting goals and implementation issues associated with ecological interactions risks will be important to help ensure successful recovery of targeted species.

Data Source: None available or known meeting criteria for inclusion.

Limitations: Not applicable.

Scoring: Not applicable.

I.2.g. *Fish health management*

Importance of the fish health management component: Fish diseases can occur in both natural and artificial circumstances. Various preventative treatments can be applied to hatchery production to manage (reduce or eliminate) the occurrences of harmful fish diseases.

Data Source: None available or known meeting criteria for inclusion.

Limitations: Not applicable.

Scoring: Not applicable.

II. VALUE OF ECOSYSTEMS TO SALMONIDS

II.1. Present ecosystem conditions

II.1.a. *Estuary development*

Importance of the estuary component: Anadromous salmon are known for their use of both the freshwater and ocean environments during their life history. The freshwater as a place to spawn and for the young to begin their growth, and the ocean as a place to feed and grow to adulthood. Migration from freshwater to saltwater as juveniles, and back again as adults, requires an important adaptation called osmoregulation. Estuaries are the ecotone where saltwater and freshwater mix, and for salmon it is also a place to begin their ocean life. By definition (Pritchard 1967), an estuary is a region where saltwater of the ocean is measurably diluted by freshwater runoff from the land within a constricted body of water. Thus, the salinity gradient that juvenile salmon encounter when migrating through estuaries depends upon the inflow of freshwater and the strength of the tides, which influences the degree of mixing, and the depth to which the juvenile salmon penetrate the water column.

Estuaries provide important rearing habitat for all seven species of salmon, but especially so for juvenile chinook and chum. They are also known to be very important rearing areas for juvenile and sub-adult anadromous bull trout. Juvenile salmon residing in estuaries prefer shallow salt marsh habitat at high tide and flowing tidal channels at low tide. Here salmon feed on a wide variety of prey that is of both aquatic and terrestrial origin. There is a great degree of variability in the size and configuration of Washington estuaries. From the large and complex estuary of the Columbia River, to the vast estuaries of rivers that flow into inland marine waters such as Puget Sound, Grays Harbor, and Willapa Bay, to the truncated and highly limited estuaries of steep coastal rivers and streams.

Estuarine wetland habitat loss has been extensive in Washington. Since Euro-American settlement, development has accounted for a major percentage of the loss of estuarine wetlands. Urban development includes urbanization, port development, industrial use, dredging and filling, and other similar activities (Bortleson et al. 1980; Simenstad et al. (1982); Boule et al. 1983; Sherwood et al. (1990); National Research Council (1996)).

Data source: Information sources used for the estuary development component were Bortleson et al. (1980); Boule et al. (1983); WDNR (1998); National Research Council (1996, pages 184-185); and ISAT knowledge.

Limitations: Although considerable information is available for much of western Washington, there were some gaps in coverage that required ISAT interpretation.

Scoring: For the purpose of rating the degree of estuary loss due to development, each estuary was placed into one of three categories of loss: favorable = 0-33% loss, medium = 34-67% loss, and unfavorable = 68-100% loss. Scoring was as follows: favorable = 10, medium = 5, and unfavorable = 0. Ratings were based on scattered and sometimes incomplete information found in the following references: Bortleson et al. (1980), Boule et al. (1983), National Research Council (1996; pages 184-185).

If more than one WRIA was located upstream on a single river, the same estuary loss value was applied to each of these WRIAs (i.e., fish from the Cowlitz, Klickitat, and Grays-Elochoman WRIAs all use the same estuary, that being the Columbia River estuary; anadromous fish in the upper Skagit WRIA use the lower Skagit WRIA estuary). Also, when two rivers refer to the same WRIA area, or when other important salmon streams were in that WRIA, we used an average estuary loss value (i.e., Lower Skagit-Samish). The most recent information was always used whenever two different references gave conflicting information.

Estuary development scores were plotted on the relative effectiveness (Y) axis because the expected response of wild salmonids from habitat protection and restoration actions will be most effective where estuary conditions are still relatively intact.

II.1.b. *Nearshore marine condition*

Importance of the nearshore marine condition component: The percentage of modified shoreline was selected as an indicator of the condition of nearshore habitat. Shoreline modification by human activities affect habitat quantity and quality directly through habitat conversion and indirectly through altering was dynamics and other physical shoreline characteristics (Thom and Shreffler 1994). Common types of shoreline modification include dredging, filling, diking, bulkheading, and riprap.

Data source: The percentage of modified marine shoreline was estimated for each western Washington WRIA by applying basin scale estimates from Bailey et al. (1998). Each WRIA was spatially nested within the appropriate basin, and the percent modification estimate for the basin as a whole was then applied to the WRIA. Bailey et al. (1998) did not estimate percent modification along the outer coast and the Columbia River. For these areas, estimates were assigned based on expert knowledge and general development patterns. Consequently, the percent of relatively undeveloped, rocky outer coast areas were classified as low. Gray's Harbor, Willapa Bay, and Columbia River areas were classified as medium due to the comparatively long history of navigation, diking, agriculture, and aquaculture.

Limitations: As noted above, information on modification along the outer coast and the Columbia River was estimated based on expert knowledge and general patterns of development.

Scoring: The percent of modified marine shoreline was estimated for each WRIA by applying basin scale estimates as noted above. Based on inspection of the distribution of data, results were grouped into the following categories: less than 25% of marine shoreline modified = favorable (10 points), 25 to 50% = medium (5 points), and more than 50% = unfavorable (0 points). Nearshore marine condition scores were plotted on the relative effectiveness (Y) axis.

II.1.c. *Forage fish*

Importance of the forage fish component: The status of forage fish populations that spawn in estuarine or lower riverine ecosystems was selected as an indicator for the general level of salmonid food resources production and availability in the estuarine ecotone. Forage fish populations are important as prey base for salmonids at numerous life history stages for both predator and prey species. Reductions in the abundance of forage fish populations is believed to have the potential to adversely affect salmonid populations. Further, a demonstrated close relationship between rates of growth and survival for salmonids suggests that even modest reductions in available prey resources may constrain salmonid population levels.

Data source: Data on forage fish stock status for herring, surf smelt, sand lance and eulachon were obtained from the Washington Department of Fish and Wildlife Forage Fish Management Plan (WDFW 1998). For herring, the individual stocks listed in table 3 of the Forage fish Management Plan were used with the additions of a Grays Harbor stock based on recent spawning observations and a Columbia River stock based upon Emmett et al. (1981). Stocks were clustered into the marine basins adapted from by Bailey et al. (1998) and each WRIA was assigned to the appropriate basin in the same manner as in the above nearshore modifications section. The exercises differ in that the San Juan - Strait of Georgia and Straits of Juan de Fuca basins are split here, but are combined in the nearshore modifications analysis. Also note that the scoring for herring in the Columbia River was only assigned to the lower most WRIA that is actually adjacent to the spawning areas. For surf smelt and sand lance, each documented spawning beach is presently considered to be a separate stock (WDFW 1998). The relatively large number of stocks were, therefore, not listed but assigned a rank of high, medium, or low by basin. Again, basin scale scores were assigned to each WRIA that was spatially nested within it. Only a single eulachon stock, occurring in the lower Columbia River and tributaries is noted in Washington. The basin scale score was assigned to each WRIA adjacent to the tidally influenced area of the mainstem..

Limitations: The data used to identify healthy and unhealthy forage fish stocks is relatively limited and is variable in quality between stocks and species (WDFW 1998). Surf smelt and sand lance stock numbers by basin were ranked as high, medium or low by visual interpretation of the documented spawning site maps in the Forage Fish Management Plan (WDFW 1998). Some stock status scores along the Strait of Juan de Fuca and outer coast were estimated based upon expert knowledge.

Scoring: Both healthy and unhealthy stock status scores were generated for the herring, surf smelt, sandlance and eulachon stocks described in the Forage Fish Management Plan (WDFW 1998) following the scoring schedule below. The resulting healthy and unhealthy scores were combined into a single forage fish ecosystem functions score. The combined forage fish score was plotted on the potential effectiveness (Y) axis. Ranked totals were essentially rated on a curve. Based on the top score the 66th and 33rd percentiles were determined. A score of 57/87 = 66% and a score of 29/87 = 33% (100-66%=10, 65=33%=5, 33-0%=-0).

Forage Fish Stock Status and Scoring			
Healthy stocks		**Unhealthy stocks**	
Healthy	3	Healthy	0
Depressed	0	Depressed	2
Critical	0	Critical	3
Unknown	0.5	Unknown	0.5

II.1.d. *Percentage of urban development*

Importance of the percentage of urban development component: Urban development can affect the quality of salmon habitat in a number of different ways. Urban development may result in the loss of physical complexity naturally inherent in western Washington streams. Streams may be cleaned out, channelized, relocated, or in some cases, run through culverts to accommodate development. Adequate riparian buffers may be encroached upon or removed resulting in reduced entrainment of large woody debris and other vegetative or ecosystem components necessary to maintain physical or biological integrity. The expected response of wild salmonids from habitat protection and restoration actions will be most effective where the source of the harm to the ecosystem can be remedied. ISAT expects the benefits to be the greatest in nonurban areas.

Data source: Data were obtained from the Washington State Land Use/Land GIS cover (LULC_L1) completed in 1996 and last updated 1997. Original data are from the mid-1970s on a 1:250,000 scale. The data were calculated as percent urban area of the WRIA area. This is identical to the data presented in Attachment 6 (III.F.4) in the draft SSRS.

Changes in watershed and stream hydrology may constitute the biggest impacts from urbanization. Large areas of impervious surfaces result in intensified peak flows and lack of water during summer droughts. For instance in a study of urbanization effects in Puget Sound lowland streams, May et al. (1997) found that "As the level of basin development increased above 5% TIA [*total impervious area*], results indicated a precipitous initial decline in biological integrity as well as the physical habitat conditions (quantity and quality) necessary to support natural biological diversity and complexity." It should be noted however that the percentage of an urban area in a watershed is not necessarily the best surrogate of TIA and will be represented in the prioritization model with road density or other suitable surrogate.

Limitations: The primary limitation of this data set is its age (see previous comment under Data Source). If the data are indeed from the mid-1970s, dramatic changes would be expected in percent urbanization in western Washington during the past two-and-a half decades.

Another possible limitation is that the percentage of urban areas may be a delineation of planning boundaries used by local planning departments or other agencies and therefore would not represent actual urban areas. More information is needed on the derivation of this data set.

Scoring: For the purpose of rating the percentage of urban development, information was placed into one of three categories: favorable, medium, and unfavorable. Scoring was as follows: favorable = 10, medium = 5, and unfavorable = 0. Information on this component was plotted on the relative effectiveness (Y) axis since urbanization is probably the least reversible form of habitat disruption and highly urbanized WRIAs will probably most often demand the most effort to achieve protection or restoration.

II.1.e. *Human population growth*

Importance of the human population growth component: People, their communities, and economies require many services and place various demands on watersheds. The size of the human population within a WRIA and the rate at which that population changes can provide key indicators about the pressures placed on wild salmonid resources. ISAT expects that emphasizing protection of WRIAs that are still experiencing low growth and restoration for WRIAs that are experiencing high growth will best recover wild salmonids.

Data source: The data for this component are estimates taken from Attachment 7 in the draft SSRS (Chapter III.F.4). Data represent human population growth data for 1990 and change projected to the year 2010. The source of this information was OFM census data.

Limitations: The state, county and local efforts to control impacts from growth were not able to be quantified and added to this measure.

Scoring: Human population growth scores were assigned according to the following: less than 10,000 = favorable (10 points); 10,000 to 50,000 = medium (5 points); over 50,000 = unfavorable (0 points). Human population growth information was plotted on the relative condition (X) axis.

II.1.f. *Water quality*

Importance of the water quality component: Good quality water is essential to maintain healthy individuals and stocks of salmonids (Reiser and Bjornn 1991; Spence et. al. 1996). Elevated stream temperatures influence salmonid health and survival at all life stages. Temperature affects appetite, metabolic rates and food conversion efficiency, as well as hatching and emergence timing. Bull trout are among the most cold-water adapted salmonids, requiring colder water temperatures than other salmonids for egg incubation and juvenile rearing. Various studies have shown (e.g., Scrivener 1988) that with increased incubation temperatures fry of anadromous salmonids emerge and migrate earlier than they otherwise would. This may result in smolt arrival to the ocean when conditions are less favorable for growth and survival (Spence et.

al. 1996). Salmonids also require high levels of dissolved oxygen. Reduced concentrations of dissolve oxygen can affect growth and development of embryos and alevins, growth of fry as well as swimming ability of adult and juvenile migrants (Spence et. al. 1996). In addition, mortality can be caused by high temperatures and by low dissolved oxygen (e.g., MacDonald et. al. 1991).

Data source: Data were obtained from a GIS-linked database of the 1996 303(d) list. Stream miles for each listed parameter were tallied by WRIA. Based on ISAT discussions, temperature and dissolved oxygen were the only parameters included in this component. This was due primarily to: (1) the importance of these parameters above all others to the direct impact on salmonid health and survival, and (2) the paucity of 303(d) listings for other parameters.

Washington State Water Quality Standards (WAC 173-201) for temperature are based on the class of waterbody. The four classes for freshwater streams are: AA-extraordinary; A-excellent; B-good; and C-fair. Temperature and dissolved standards for the four classes are as follows:

Class	**Temp. Std. (°C)**	**DO Std. (mg/L)**
AA	16.0	9.5
A	18.0	8.0
B	21.0	6.5
C	22.0	4.0

Limitations: The primary limitation is that only a small percentage of stream miles across the state have been assessed for water quality. However, it should be noted that assessments are generally conducted in waterbodies suspected of having poor water quality. In most cases, water quality assessments lead to inclusion on the 303(d) list.

Waterbodies are dropped from 303(d) by: (1) demonstrating they meet water quality standards, or (2) establishing a TMDL (total maximum daily load). A waterbody with a TMDL may be removed from 303(d) even if it doesn't meet WQ standards. Therefore, the 303(d) list does not offer a true picture of water quality. Only a handful of TMDLs have been implemented so far although Ecology has an agreement with EPA to have TMDLs for all 636 listed waterbodies within the next 15 years.

Finally, the data used for this component is from the 1996 303(d) list. EPA has not yet approved the more recent 1998 list.

Scoring: Scoring was done on the relative condition (X) axis to emphasize restoration in WRIAs that have poor water quality conditions and protection for WRIAs that have the best water quality. Water quality information for each WRIA was categorized based on inspection of the data distribution for natural break points. This resulted in scores for each WRIA being assigned to one of five categories as follows: 10 (0 miles); 8 (0-10 miles); 6 (10-50 miles); 4 (50-100 miles); 2 (100-150 miles); 0 (>150 miles). The use of five categories for this component departs from most other components that typically broken down into three categories. However, ISAT felt this approach was justified and consistent with the available information.

II.1.g. Percentage of land in agricultural use

Importance of the agricultural land use component: Agriculture is a large, diverse, and important component of Washington's economy. Because it is such a large component, agricultural practices can have major effects on the landscape, including the structure and function of watersheds and fish communities. These influences can have a major impact wild fish resources (e.g., Platts 1991; National Research Council 1996; Spence et al. 1996).

Data source: Data for the agricultural land use component were obtained from the Washington State Land Use/Land GIS cover (LULC_L1) completed in 1996 and last updated 1997. Original data are from the mid-1970s on a 1:250,000 scale. The data were calculated as the total agricultural acreage as a percentage of the total WRIA area. This is identical to the data presented in Attachment 4 (III.F.4) in the draft SSRS.

Limitations:

Scoring: Agricultural land use scores were assigned according to the following: less than 25%, favorable = 10, 25-75%, medium = 5; over 75%, unfavorable = 0. Agricultural land use information was plotted on the relative condition (X) axis.

II.1.h. Forest seral stage along streams

Importance of the forest seral stage along streams component: Forests along Washington's salmonid streams (riparian forests) are of key importance for water temperature moderation, nutrient/food web production, and sustenance of normal sediment and erosion processes. In addition, these forests provide the large trees and other wood that falls into streams allowing restoration and maintenance of complex pool/riffle habitats used by salmonids.

Data source: Information from Lunetta et al. (1997) was used for this component. That work was sponsored by the U.S. Environmental Protection Agency and was directed at WRIAs in Western Washington. First, streams were classed into source, transport and response reaches (as per Montgomery and Buffington 1993) through GIS evaluation of a 1:24,000 scale hydrography layer and 1:24,000 digital elevation model. Response reaches (those with slopes <0.04) were identified as the reach type most likely to contain anadromous salmonid habitat. These reaches were then coupled with Landsat data (1988 with updates from 1991 and 1993) for late and mid seral stages.

Late seral stage was defined by Lunetta et al. as: coniferous crown cover greater than 70%; more than 10% crown cover in trees greater than or equal to 21 inches diameter breast height (dbh);. mid seral stage: coniferous crown cover greater than 70%, and less than 10% crown cover in trees greater than or equal to 21 inches dbh. A riparian area width of 30 meters each side of the stream was used.

Using the above information, the percent of late and mid seral stages along response reaches was calculated for each WRIA.

Limitations: The associations between individual salmonid species and gradient needs to be further considered. For example, fish species/stocks using stream reaches with gradients >4% (e.g., native resident trout and char species) are not covered with this approach.

Scoring: Scores were assigned as follows:

Groupings	Rating	Score
Top 1/3 percentile of WRIAs	Favorable	10
Middle 1/3 percentile of WRIAs	Medium	5
Lowest 1/3 percentile of WRIAs	Unfavorable	0

These scores are plotted on the relative condition (X) axis. Maintaining or restoring mid to late seral stage riparian areas is of primary importance for salmonid protection and restoration.

II.1.i. *Channel gradient - productivity*

Importance of the channel gradient component: Generally, the diversity of stream fish communities (including salmon) decreases from the lower portions of river basins to their steep headwater channels (Reeves et al. 1998). One of the strongest controls on salmonid access into drainage basins is stream channel gradient. The higher the gradient, the steeper the channel, and the more difficult it is for salmon to migrate. Typically, one can expect to find the bulk of anadromous salmon species in the lower gradient channels close to saltwater.

In many cases salmon and cutthroat trout distributions mirror the distribution of gradient ranges typical for different channel morphologies. For example, the cutthroat trout-only zone correlates with stream gradients >3%, the chinook zone correlates with gradients <1%, and the coho zone correlates with gradients of 1-3% (Montgomery et al. 1999).

It is probably reasonable to assume that the greatest numbers of commercially valuable salmon species are produced in gradients of 4% or less (Lunetta et al.1997). However, it is important to point out that many important nonanadromous forms of fish, such as rainbow, cutthroat and bull trout, can also be found in headwater streams approaching 20-30% gradients. Bull trout spawning occurs primarily in low gradient reaches of higher gradient headwater streams.

For present purposes ISAT assumed that the WRIAs having streams with gradients of 4% or less, have the greatest potential to produce anadromous salmonids.

Data source: The source of information for this component was Lunetta et al. (1997) [see also the forest seral stage along streams component.

A stream channel classification system suggested by Montgomery and Buffington (1993) broadly stratifies channel morphology influences of LWD, and can be applied over large areas on the basis of correlations with reach gradient. That study identifies three kinds of reaches: source, transport, and response. Source reaches tend to be located in the high gradient headwaters of rivers, transport reaches tend to be in the middle gradient morphologies, and response reaches tend to be in the lower gradient channels - where most salmonids reside.

Field data used to validate stream channel type predictions were provided as part of an on-going salmon habitat inventory and management effort by Lunetta et al. (1997). Inventory efforts focused primarily on stream reaches with relatively low channel gradients (<4 %) and were compiled on 1:12,000-scale orthophotos.

Limitations: As noted for the Forest cover - seral stage component, the 4% gradient condition is unlikely to apply equally well to all salmonid species. For example, nonanadromous salmonids, such as rainbow, cutthroat and bull trout, can also be found in high gradient headwater streams approaching 20-30% gradients.

Scoring: WRIA scale data on response channel density from Lunetta et al. (1997) were rated from low to high. Based on the range of density values across WRIAs, scores were assigned after the rated data were sorted into percentiles by thirds. Scores were assigned as follows: favorable density = 10, medium = 5, and unfavorable density = 0. Channel gradient scores were plotted on the relative effectiveness (Y) axis.

II.1.j. *Impervious surfaces - road density*

Importance of the impervious surfaces component: Human activities, including road building, can increase or decrease streamflows, cause flows to become more or less variable than the natural discharge regime, and alter the timing of seasonal runoff patterns. This can force large quantities of water through channels in a more frequent time-span than would otherwise occur under natural conditions. Changes in stream flow result from water impoundments, water withdrawals, enlargement or shrinkage of the effective drainage network, increase in the imperviousness of soil surface, altering the rapidity of runoff, altering groundwater quantities or movements, altering the depth of coarse and fine sediments in the stream, altering streamside and hillslope vegetation via forest-management practices, and the conversion of forest land to other uses such as agriculture and urbanization (National Research Council 1996).

When forest land is converted to other purposes, the result is that less water is able to be absorbed into the soil mantle and reach the groundwater. Forest roads, highways, parking lots, rooftops, and all other impervious surfaces, force precipitation to directly run off into drainage channels, and eventually end up in salmon streams. Logging affects surface and groundwater hydrology in complex ways (Chamberlin et al. 1991), and studies have indicated that the frequency and magnitude of stream discharge peaks are sometimes increased after clearcutting. Forestry activities-including increased road construction, timber falling and yarding, slash burning, and mechanical scarification-can all cause water to reach streams more rapidly (Harr et al. 1975). Although soil compaction can occur with almost any type of land use, effects are often most pronounced in urban and industrial settings, where extensive roads and paving can effectively double the frequency of hydrologic events that are capable of mobilizing stream substrates (Booth 1991).

For the purpose of estimating the extent of impermeable surfaces within WRIAs, ISAT used road density information as a surrogate index.

Data source: WDNR Geographic Information System - Digital Data Layers (i.e., WRIA, transportation).

Limitations: Although road density was felt to be a reasonable broad scale surrogate of the relative extent of impervious surface in western Washington, factors other than road density contribute to impervious surfaces, and to the extent feasible, should receive additional consideration in future iterations.

Scoring: For the purpose of rating the extent of impermeable surfaces, road density information for each WRIA was partitioned into either favorable, medium, or unfavorable categories. Scoring was: favorable = 10, medium = 5, and unfavorable = 0. Scores were plotted on the X (relative condition) axis.

II.1.k. *Extent of hydrologic modification*

Importance of the hydrologic modification component: The extent of hydrologic modification is an indicator of the extent of flow pattern change among WRIAs. The process of impounding streams alters stream characteristics and removes flowing water habitat when reservoirs fill. This information is part of EPA's index of watershed indicators (IWI) and relates to the extent of reservoir impoundments in a watershed.

Data source: EPA's Index of Watershed Indicators. The index was based on relative reservoir impoundment volume in a watershed. Hydrologic modification information was assessed by EPA

Limitations: The Index of Watershed Indicators is a broad characterization of watersheds and does not contain detailed site-specific information on the impacts of individual dams or the estimated cumulative effects of them on wild salmonids.

Scoring: EPA scored each H.C. (hydrologic condition) as high, medium and low. ISAT scored these assessments for WRIAs as 10 = favorable, 5 = medium, and 0 = unfavorable, respectively. Where geographic boundaries of H.C.'s were not the same as WRIAs and the H.C. scores were different, ISAT averaged the EPA scores. ISAT scored this measure on the Y axis because the greater the hydrologic modification, the lower the anticipated efficiency and benefit of restoration and protection efforts.

II.1.l. *Fish passage constraints*

Importance of the fish passage constraint component: Fish passage can seriously limit access of the capacity or extent of area available to juvenile and/or adult salmonids to needed habitats during one or more phases of their life cycle.

Data source: Fish passage constraints were determined by the fish passage task force (WDFW and WSDOT). ISAT used the number of identified WSDOT barrier culverts as an indicator of the magnitude of passage constraints in the WRIA (Johnson et al. (1998), Appendix 1, Sept. 1998 report). ISAT chose WSDOT culvert passage barriers as a measure of restorable migration barriers by WRIA. This report summarized 564 culvert crossings and identified 233 that needed repair, 183 that needed further evaluation, and 159 that had insufficient habitat gain. All categories were included as the indicator of the extent of barriers in each WRIA.

Limitations: State highways are one type of development that may result in blockages to fish migrations. The data used here represent WSDOT's work and may not represent overall characteristics within all WRIAs to the extent that differing types of development or land use are involved.

Scoring: WRIA 20 had the most barriers with 45 so ISAT multiplied .67 X 45 = 30, and .33 X 45 = 15 as the break points. WRIAs with large numbers of barriers (>30) were unfavorable (0 points), 15- 30 barriers = medium (5 points), and <15 barriers = favorable (10 points). ISAT scored this data on the X-axis to emphasize restoration in areas with the most barriers and protection in areas with fewer barriers.

II.2. Water availability and distribution

II.2.a. *Water availability for fish*

Importance of the water for fish component: Wild salmonids need water in adequate amounts at the right times and in the right places. An adequate quantity of cool, clean water is a critical habitat requirement for sustainable fish production in streams. Fish have adapted over millennia to the natural flow regimes in individual watersheds. Without adequate water, survival of fish is simply not possible.

Natural flow conditions have been affected by various human activities in the past century (Chamberlin et al. 1991; National Research Council 1996; Spence et al. 1996) including diversions for irrigation, municipal, and industrial uses; storage in reservoirs for hydropower, groundwater withdrawals, and accelerated runoff due to logging, roadbuilding, and other increases in impervious surfaces due to growth and human development.

Data source: The data source for the water for fish component was the draft SSRS, Chapter III.B.5. and Appendix III.B.5. Numerous reports and IFIM studies were used in compiling information for that chapter, including watershed assessments conducted by the Washington Department of Ecology in 1995, WDFW's Watershed Recovery Inventory Program (1997), and other information from Ecology and WDFW.

The draft SSRS provides a comprehensive overview of the water availability for fish and its relationship to the establishment of instream flows. The data include lists of basins: (I) that are overappropriated, (II) where instream flows are set but are inadequate for fish, (III) where adequacy of water for fish is unknown, (IV) where no instream flows are set, but high development pressure exists, and (V) where no instream flows are set, but low development pressure exists.

Limitations: Determining the adequacy of flows to meet the all the ecosystem and life history needs of salmonids is extremely challenging. There are few data sources that are available on a comprehensive basis. ISAT felt the information in the draft SSRS was adequate for this prioritization exercise. However, ISAT felt that the relationship between flows and the needs of salmonids, and actual databases on water available for that purpose, could be improved.

Scoring: Information on the adequacy of water available for fish was rated as favorable (10 points), medium (5 points), or unfavorable (0 points) based on the five categories mentioned above (category I=unfavorable, II-IV=medium, V=favorable). The category groupings were viewed in combination with the narrative descriptions provided in Appendix III.B.5 of the draft SSRS to rate each WRIA.

II.2.b. *Frequency of peak flows*

Importance of the frequency of peak flows component: Hydrographs in undisturbed watersheds typically are much different from those in watersheds that have received some extent of natural of anthropogenic disturbance. One common and important characteristic of hydrographs in disturbed watershed is that peak flows tend to occur more often. This can have serious adverse consequences for wild salmonids at one or more stages in their life cycle. For example, it is not unusual for the frequency of peak flows to increase in seasons and at times when wild spawners are in the process of, or have recently, deposited eggs in stream gravels for incubation. Increased peak flow frequencies can cause large losses of incubating eggs.

Data Source: Basin-wide evaluations of change in peak flow frequency are not available for western Washington. The USGS has information useful for this work.

Limitations: Not applicable.

Scoring: Not applicable.

II.2.c. *Low flow limitations (compared to natural state flows)*

Importance of the low flow limitation component: As with peak flows, in undisturbed watersheds the life histories of wild salmonids are well matched to hydrographs so that water is available at the right times and places. Life histories can be severely disrupted or even eliminated if water becomes overly limited at critical times.

Data Source: Basin-wide evaluations of change in low flows are not available for western Washington. As with peak flows, the USGS has information useful for this work.

Limitations: Not applicable.

Scoring: Not applicable.

II.3. Extent of intact ecosystem

II.3.a. *Extent of protected lands*

Importance of the protected lands component: In general, a direct relationship exists between salmonid habitat quality/quantity and areas that are managed specifically to protect natural values. This relationship is embodied by the identification of "key watersheds" in the Northwest Forest Plan (FEMAT 1993) and other conservation systems. These areas, in which development or other human uses are strictly regulated or avoided, generally receive the greatest level of protection from development and other activities that can affect wild salmonid resources. For present purposes, the percentage of land in each WRIA managed in the following designations was identified: U. S. National Park Service, U. S. Forest Service "Wilderness Areas", and Washington State Department of Natural Resources "Natural Resource Conservation Area" and "Natural Area Preserve" lands. For each WRIA, the total percentage of these protected lands was obtained by totaling the amount of land area in these four categories and dividing that number by the total area of the respective WRIA.

Data source: The information came from the Washington Department of Natural Resources Geographic Information System Digital Data Layers (i.e., WRIA layer, NRC/NAPA public lands data base).

Limitations: The level of protection afforded to fish by different land management classifications can be variable. In general, ISAT used broad land management categories that provided a high degree of natural resource protection, and on a comprehensive scale. ISAT recognizes that other land management classifications may also protect salmonids; these can be considered in the future.

Scoring: The WRIAs were evenly divided into favorable, medium, and unfavorable categories. The favorable category contained WRIAs with the most protected land (12-52%) and got 10 points, the medium category (1.6-10%) received 5 points, and the unfavorable category (0-1%) received 0 points. As noted earlier WRIAs containing the highest levels of protected lands are most likely to have the best opportunities for additional land protections, or might be best able to contribute to networks or systems of protected lands in adjacent areas. Thus, scores were plotted on the relative condition (X) axis.

II.3.b. *Extent of stronghold areas*

Importance of the stronghold areas component: The presence of strong or abundant populations of wild salmonids usually reflects conditions that have been and continue to be favorable for population persistence. These can be important in providing sources for stock rebuilding into less favorable adjacent areas as they respond positively to protection and restoration efforts. In general, because strongholds provide the best examples of existing "principle" from which "interest" may accrue, they should receive high priority protection emphasis.

Data Source: None available or known meeting criteria for inclusion at this time.

Limitations: Not applicable.

Scoring: Not applicable.

II.3.c. *Aquatic biodiversity*

Importance of the aquatic biodiversity component: Similar to the stronghold areas component above, the presence of diverse aquatic communities of species that are indigenous to Washington in watersheds generally reflects more favorable existing conditions for wild salmonids than in watersheds where the type and extent of native aquatic biodiversity has been reduced. The presence of non-salmonid fishes, amphibians, and invertebrates are important indicators of watershed condition and thus would be important areas for protection and restoration of habitat for wild salmonids.

Data Source: None available or known meeting criteria for inclusion at this time.

Limitations: Not applicable.

Scoring: Not applicable.

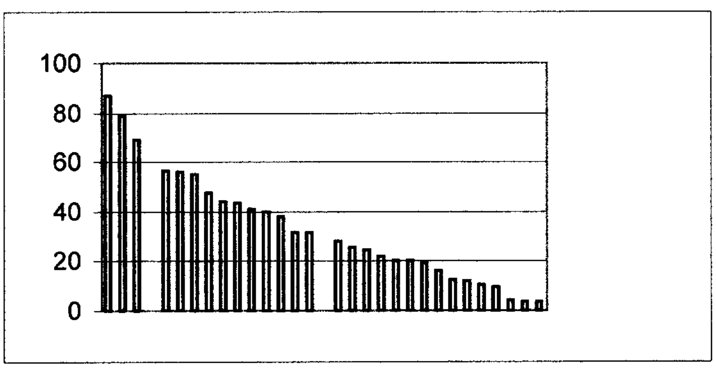
Appendix 2

Source data summaries for individual information components

I.1.a. SSRS PRIORITIZATION - TOTAL HEALTHY STOCK SIGNIFICANCE (SASSI + ESA)

Category	Y-axis points	
Favorable	10	>67%
Medium	5	33%-67%
Unfavorable	0	<33%

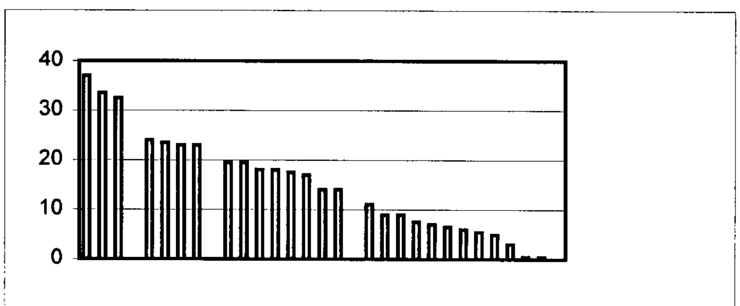
WRIA		Value	Score
20	Sol Duc - Hoh	87	10
21	Queets - Quinault	79	10
22	Lower Chehalis	69	10
15	Kitsap	56.5	5
7	Snohomish	56	5
16	Hood Canal	55	5
3	Lower Skagit - Samish	47.5	5
19	Lyre - Hoko	44	5
24	Willapa	43.5	5
14	Kennedy-Goldsbgh.	41	5
10	Puyallup	40	5
5	Stillaguamish	38	5
9	Duamish-Green	31.5	5
23	Upper Chehalis	31.5	5
11	Nisqually	28	0
1	Nooksack	25.5	0
18	Elwha - Dungeness	24.5	0
13	Deschutes	22	0
17	Quilcene	20	0
27	Lewis - Kalama	20	0
25	Grays - Eloc.	19	0
8	Cedar-Sammamish	16	0
26	Cowlitz	12.5	0
12	Chambers-Clover	12	0
29	Wind - White Sal.	10.5	0
28	Salmon - Washougal	9.5	0
4	Upper Skagit	4	0
2	San Juan	3.5	0
6	Island	3.5	0



I.1.b. SSRS PRIORITIZATION - TOTAL UNHEALTHY STOCK SIGNIFICANCE (SASSI + ESA)

Category	X-axis points	
Favorable	10	<33%
Medium	5	33%-67%
Unfavorable	0	>67%

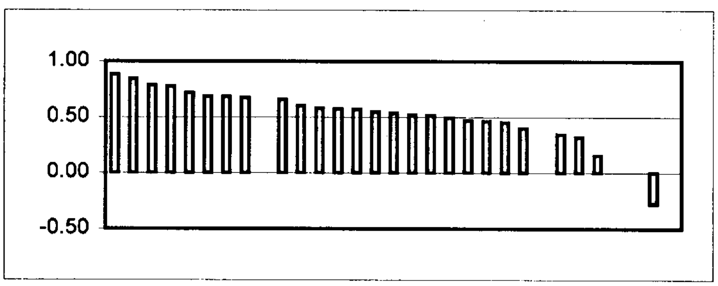
WRIA		Value	Score
25	Grays - Eloc.	37	0
18	Elwha - Dungeness	33.5	0
26	Cowlitz	32.5	0
27	Lewis - Kalama	24	5
3	Lower Skagit - Samish	23.5	5
16	Hood Canal	23	5
17	Quilcene	23	5
1	Nooksack	0	5
15	Kitsap	19.5	5
28	Salmon - Washougal	19.5	5
20	Sol Duc - Hoh	18	5
21	Queets - Quinault	18	5
29	Wind - White Sal.	17.5	5
8	Cedar-Sammamish	17	5
5	Stillaguamish	14	5
7	Snohomish	14	5
10	Puyallup	11	10
19	Lyre - Hoko	9	10
22	Lower Chehalis	9	10
9	Duamish-Green	7.5	10
11	Nisqually	7	10
24	Willapa	6.5	10
14	Kennedy-Goldsbgh.	6	10
23	Upper Chehalis	5.5	10
13	Deschutes	5	10
4	Upper Skagit	3	10
2	San Juan	0.5	10
6	Island	0.5	10
12	Chambers-Clover	0	10



I.1.c. SSRS PRIORITIZATION - TOTAL STOCK ORIGIN (SASSI)

Category	Y-axis points	
Favorable	10	>67%
Medium	5	33%-67%
Unfavorable	0	<33%

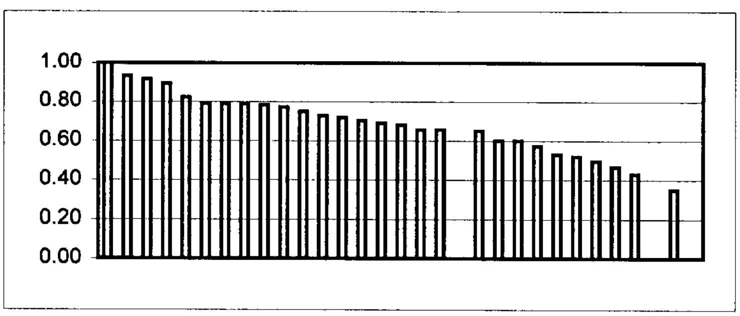
WRIA	Value	Scaled	Score
4 Upper Skagit	75	0.88	10
24 Willapa	63	0.84	10
28 Salmon - Washougal	43	0.78	10
20 Sol Duc - Hoh	151	0.77	10
21 Queets - Quinault	118	0.72	10
5 Stillaguamish	41	0.68	10
11 Nisqually	17	0.68	10
14 Kennedy-Goldsbgh.	57	0.67	10
1 Nooksack	49	0.65	5
27 Lewis - Kalama	42	0.60	5
22 Lower Chehalis	78	0.58	5
7 Snohomish	54	0.57	5
19 Lyre - Hoko	51	0.57	5
17 Quilcene	30	0.55	5
10 Puyallup	32	0.53	5
18 Elwha - Dungeness	39	0.52	5
23 Upper Chehalis	18	0.51	5
25 Grays - Eloc.	47	0.49	5
12 Chambers-Clover	7	0.47	5
16 Hood Canal	53	0.46	5
15 Kitsap	45	0.45	5
26 Cowlitz	28	0.40	5
3 Lower Skagit - Samish	12	0.34	0
29 Wind - White Sal.	19	0.32	0
8 Cedar-Sammamish	7	0.16	0
2 San Juan	0	0.00	0
9 Duamish-Green	0	0.00	0
13 Deschutes	-7	-0.28	0
6 Island	No Data		



I.1.d. SSRS PRIORITIZATION - TOTAL PRODUCTION TYPE OF NATURAL SPAWNERS (SASSI)

Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Scaled	Score
2	San Juan	10	1.00	10
5	Stillaguamish	56	0.93	10
7	Snohomish	87	0.92	10
24	Willapa	67	0.89	10
8	Cedar-Sammamish	37	0.82	10
19	Lyre - Hoko	71	0.79	10
4	Upper Skagit	67	0.79	10
1	Nooksack	59	0.79	10
28	Salmon - Washougal	43	0.78	10
23	Upper Chehalis	27	0.77	10
20	Sol Duc - Hoh	146	0.75	10
21	Queets - Quinault	120	0.73	10
14	Kennedy-Goldsbgh.	61	0.72	10
22	Lower Chehalis	95	0.70	10
17	Quilcene	38	0.69	10
11	Nisqually	17	0.68	10
3	Lower Skagit - Samish	23	0.66	10
27	Lewis - Kalama	46	0.66	10
10	Puyallup	39	0.65	5
16	Hood Canal	69	0.60	5
29	Wind - White Sal.	36	0.60	5
18	Elwha - Dungeness	43	0.57	5
15	Kitsap	53	0.53	5
13	Deschutes	13	0.52	5
25	Grays - Eloc.	47	0.49	5
12	Chambers-Clover	7	0.47	5
26	Cowlitz	30	0.43	5
9	Duamish-Green	14	0.35	0
6	Island	No Data		



I.1.e. SSRS PRIORITIZATION - TOTAL GENETIC DIVERSITY VALUE

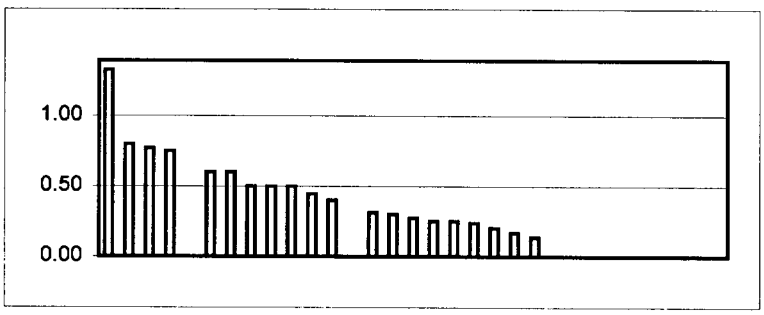
Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Score
1	Nooksack	10
3	Lower Skagit - Samish	10
4	Upper Skagit	10
5	Stillaguamish	10
7	Snohomish	10
8	Cedar-Sammamish	10
10	Puyallup	10
11	Nisqually	10
14	Kennedy-Goldsbgh.	10
15	Kitsap	10
16	Hood Canal	10
17	Quilcene	10
18	Elwha - Dungeness	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
22	Lower Chehalis	10
23	Upper Chehalis	10
27	Lewis - Kalama	10
28	Salmon - Washougal	10
29	Wind - White Sal.	10
9	Duamish-Green	5
12	Chambers-Clover	5
13	Deschutes	5
24	Willapa	5
25	Grays - Eloc.	5
26	Cowlitz	5
2	San Juan	
6	Island	

I.2.a. SSRS PRIORITIZATION - TOTAL PROPORTION STOCKS OVERFISHED (WSP)

Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Scaled	Score
24	Willapa	12	1.33	0
26	Cowlitz	8	0.80	0
25	Grays - Eloc.	10	0.77	0
27	Lewis - Kalama	6	0.75	0
15	Kitsap	9	0.60	5
28	Salmon - Washougal	3	0.60	5
9	Duamish-Green	3	0.50	5
11	Nisqually	2	0.50	5
12	Chambers-Clover	1	0.50	5
10	Puyallup	4	0.44	5
29	Wind - White Sal.	2	0.40	5
16	Hood Canal	5	0.31	10
18	Elwha - Dungeness	3	0.30	10
14	Kennedy-Goldsbgh.	3	0.27	10
8	Cedar-Sammamish	2	0.25	10
13	Deschutes	1	0.25	10
20	Sol Duc - Hoh	5	0.24	10
1	Nooksack	2	0.20	10
3	Lower Skagit - Samish	1	0.17	10
21	Queets - Quinault	3	0.14	10
2	San Juan	0	0.00	10
4	Upper Skagit	0	0.00	10
5	Stillaguamish	0	0.00	10
7	Snohomish	0	0.00	10
17	Quilcene	0	0.00	10
19	Lyre - Hoko	0	0.00	10
22	Lower Chehalis	0	0.00	10
23	Upper Chehalis	0	0.00	10
6	Island	No Data		



I.2.b. SSRS PRIORITIZATION - TOTAL ESCAPEMENT GOALS - ADEQUACY OF SPAWNERS

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Score
2	San Juan	10
22	Lower Chehalis	10
3	Lower Skagit - Samish	5
4	Upper Skagit	5
5	Stillaguamish	5
7	Snohomish	5
14	Kennedy-Goldsbgh.	5
15	Kitsap	5
16	Hood Canal	5
17	Quilcene	5
19	Lyre - Hoko	5
20	Sol Duc - Hoh	5
21	Queets - Quinault	5
23	Upper Chehalis	5
1	Nooksack	0
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0
11	Nisqually	0
12	Chambers-Clover	0
13	Deschutes	0
18	Elwha - Dungeness	0
24	Willapa	0
25	Grays - Eloc.	0
26	Cowlitz	0
27	Lewis - Kalama	0
28	Salmon - Washougal	0
29	Wind - White Sal.	0
6	Island	

I.2.c. SSRS PRIORITIZATION - TOTAL HATCHERY FISH IDENTIFICATION

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Score
22	Lower Chehalis	5
23	Upper Chehalis	5
24	Willapa	5
25	Grays - Eloc.	5
26	Cowlitz	5
27	Lewis - Kalama	5
28	Salmon - Washougal	5
29	Wind - White Sal.	5
1	Nooksack	0
2	San Juan	0
3	Lower Skagit - Samish	0
4	Upper Skagit	0
5	Stillaguamish	0
6	Island	0
7	Snohomish	0
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0
11	Nisqually	0
12	Chambers-Clover	0
13	Deschutes	0
14	Kennedy-Goldsbgh.	0
15	Kitsap	0
16	Hood Canal	0
17	Quilcene	0
18	Elwha - Dungeness	0
19	Lyre - Hoko	0
20	Sol Duc - Hoh	0
21	Queets - Quinault	0

I.2.d. SSRS PRIORITIZATION - TOTAL NATURAL JUVENILE PRODUCTION ASSESSMENT

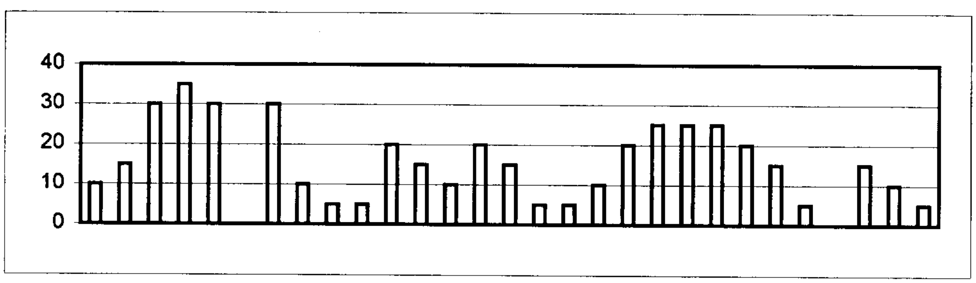
Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Score
3	Lower Skagit - Samish	10
4	Upper Skagit	10
8	Cedar-Sammamish	10
13	Deschutes	10
15	Kitsap	10
17	Quilcene	10
18	Elwha - Dungeness	10
19	Lyre - Hoko	10
21	Queets - Quinault	10
22	Lower Chehalis	10
23	Upper Chehalis	10
27	Lewis - Kalama	10
29	Wind - White Sal.	10
5	Stillaguamish	5
7	Snohomish	5
9	Duamish-Green	5
10	Puyallup	5
11	Nisqually	5
12	Chambers-Clover	5
14	Kennedy-Goldsbgh.	5
16	Hood Canal	5
24	Willapa	5
25	Grays - Eloc.	5
28	Salmon - Washougal	5
1	Nooksack	0
2	San Juan	0
6	Island	0
20	Sol Duc - Hoh	0
26	Cowlitz	0

I.2.e. SSRS PRIORITIZATION - RATIO OF HATCHERY TO NATURAL PRODUCTION

Category	X-axis points
Hatchery < 2X Natural	10
Hatchery = Natural	5
Hatchery > 2X Natural	0

WRIA	Hatchery Ratio Chinook	Hatchery Ratio Coho	Hatchery Ratio Chum	Hatchery Ratio Steelhead	Hatchery Ratio Sum	X-axis points
1 Nooksack	0	0	5	5	10	0
2 San Juan	0	5	5	5	15	5
3 Lower Skagit - Samish	5	10	10	5	30	10
4 Upper Skagit	10	10	10	5	35	10
5 Stillaguamish	5	10	10	5	30	10
6 Island						
7 Snohomish	5	10	10	5	30	10
8 Cedar-Sammamish	0	0		10	10	0
9 Duamish-Green	0	0	0	5	5	0
10 Puyallup	0	0	0	5	5	0
11 Nisqually	0	0	10	10	20	5
12 Chambers-Clover	0	0	10	5	15	5
13 Deschutes	0	10		0	10	0
14 Kennedy-Goldsbgh.	5	0	10	5	20	5
15 Kitsap	0	0	10	5	15	5
16 Hood Canal	0	0	0	5	5	0
17 Quilcene	0	0	0	5	5	0
18 Elwha - Dungeness	0	0	5	5	10	0
19 Lyre - Hoko	0	5	10	5	20	5
20 Sol Duc - Hoh	5	5	10	5	25	10
21 Queets - Quinault	5	5	10	5	25	10
22 Lower Chehalis	5	5	10	5	25	10
23 Upper Chehalis	5	5	10	0	20	5
24 Willapa	0	0	10	5	15	5
25 Grays - Eloc.	0	0	5	0	5	0
26 Cowlitz	0	0		0	0	0
27 Lewis - Kalama	5	5		5	15	5
28 Salmon - Washougal	0	0	10	0	10	0
29 Wind - White Sal.	0	0		5	5	0



II.1.a. SSRS PRIORITIZATION - TOTAL ESTUARY DEVELOPMENT

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Estuary Development
1	Nooksack	10
2	San Juan	10
5	Stillaguamish	10
6	Island	10
11	Nisqually	10
16	Hood Canal	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
22	Lower Chehalis	10
23	Upper Chehalis	10
12	Chambers-Clover	5
14	Kennedy-Goldsbgh.	5
15	Kitsap	5
17	Quilcene	5
18	Elwha - Dungeness	5
24	Willapa	5
3	Lower Skagit - Samish	0
4	Upper Skagit	0
7	Snohomish	0
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0
13	Deschutes	0
25	Grays - Eloc.	0
26	Cowlitz	0
27	Lewis - Kalama	0
28	Salmon - Washougal	0
29	Wind - White Sal.	0

II.1.b. SSRS PRIORITIZATION - NEAR-SHORE MARINE CONDITION

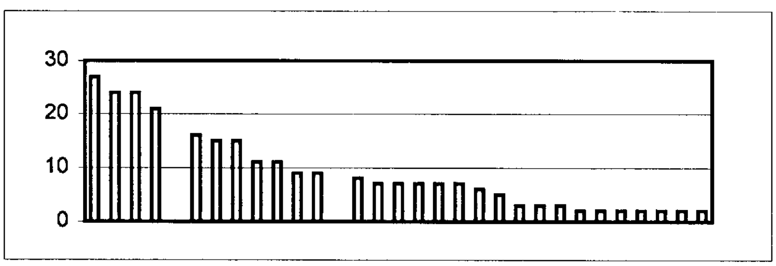
Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Marine Shoreline
1	Nooksack	10
2	San Juan	10
18	Elwha - Dungeness	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
3	Lower Skagit - Samish	5
4	Upper Skagit	5
5	Stillaguamish	5
6	Island	5
7	Snohomish	5
11	Nisqually	5
12	Chambers-Clover	5
13	Deschutes	5
14	Kennedy-Goldsbgh.	5
15	Kitsap	5
16	Hood Canal	5
17	Quilcene	5
22	Lower Chehalis	5
23	Upper Chehalis	5
24	Willapa	5
25	Grays - Eloc.	5
26	Cowlitz	5
27	Lewis - Kalama	5
28	Salmon - Washougal	5
29	Wind - White Sal.	5
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0

II.1.c. SSRS PRIORITIZATION - MARINE FORAGE FISH

Category	X-axis points	
Favorable	10	>67%
Medium	5	33%-67%
Unfavorable	0	<33%

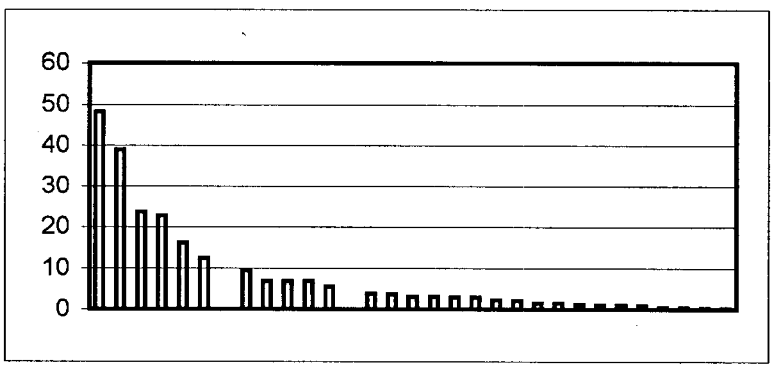
WRIA		Value	Marine Forage Fish
15	Kitsap	27	10
3	Lower Skagit - Samish	24	10
4	Upper Skagit	24	10
17	Quilcene	21	10
6	Island	16	5
1	Nooksack	15	5
2	San Juan	15	5
5	Stillaguamish	11	5
7	Snohomish	11	5
8	Cedar-Sammamish	9	5
9	Duamish-Green	9	5
24	Willapa	8	0
10	Puyallup	7	0
11	Nisqually	7	0
12	Chambers-Clover	7	0
13	Deschutes	7	0
14	Kennedy-Goldsbgh.	7	0
18	Elwha - Dungeness	6	0
16	Hood Canal	5	0
22	Lower Chehalis	3	0
23	Upper Chehalis	3	0
19	Lyre - Hoko	3	0
25	Grays - Eloc.	2	0
26	Cowlitz	2	0
27	Lewis - Kalama	2	0
28	Salmon - Washougal	2	0
29	Wind - White Sal.	2	0
20	Sol Duc - Hoh	2	0
21	Queets - Quinault	2	0



II.1.d. SSRS PRIORITIZATION - TOTAL URBAN DEVELOPMENT %

Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Score
12	Chambers-Clover	48.3	0
8	Cedar-Sammamish	38.9	0
9	Duamish-Green	23.6	0
28	Salmon - Washougal	22.6	0
13	Deschutes	16.2	0
15	Kitsap	12.5	0
10	Puyallup	9.4	5
6	Island	7	5
14	Kennedy-Goldsbgh.	7	5
3	Lower Skagit - Samis	6.9	5
7	Snohomish	5.6	5
1	Nooksack	3.9	10
25	Grays - Eloc.	3.7	10
5	Stillaguamish	3.1	10
17	Quilcene	3.1	10
27	Lewis - Kalama	3	10
11	Nisqually	2.9	10
22	Lower Chehalis	2.3	10
23	Upper Chehalis	2.2	10
18	Elwha - Dungeness	1.6	10
24	Willapa	1.6	10
26	Cowlitz	1.3	10
2	San Juan	1.1	10
29	Wind - White Sal.	1.1	10
16	Hood Canal	1	10
20	Sol Duc - Hoh	0.5	10
21	Queets - Quinault	0.5	10
4	Upper Skagit	0.3	10
19	Lyre - Hoko	0.3	10



II.1.e. SSRS PRIORITIZATION - HUMAN POPULATION GROWTH

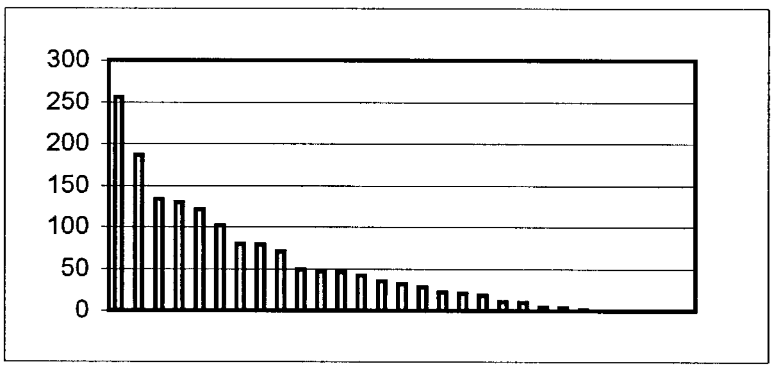
Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Human Population Growth
2	San Juan	10
4	Upper Skagit	10
16	Hood Canal	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
24	Willapa	10
29	Wind - White Sal.	10
3	Lower Skagit - Samish	5
5	Stillaguamish	5
6	Island	5
11	Nisqually	5
14	Kennedy-Goldsbgh.	5
17	Quilcene	5
18	Elwha - Dungeness	5
22	Lower Chehalis	5
23	Upper Chehalis	5
25	Grays - Eloc.	5
26	Cowlitz	5
27	Lewis - Kalama	5
1	Nooksack	0
7	Snohomish	0
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0
12	Chambers-Clover	0
13	Deschutes	0
15	Kitsap	0
28	Salmon - Washougal	0

II.1.f. SSRS PRIORITIZATION - TOTAL STREAM WATER QUALITY - 303d RESPONSE MILES

Category X-axis points

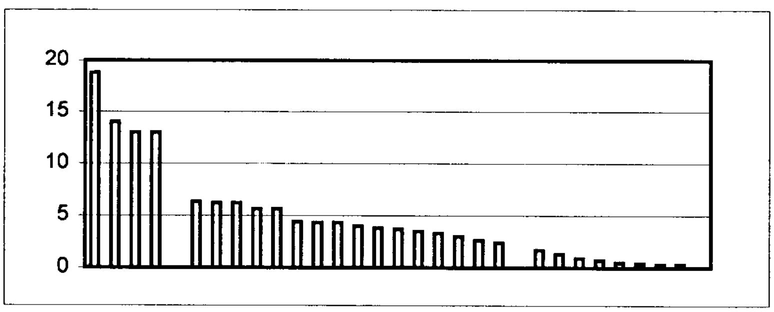
WRIA		Value	Score
20	Sol Duc - Hoh	255.48	0
7	Snohomish	186.49	0
26	Cowlitz	132.69	2
24	Willapa	128.98	2
22	Lower Chehalis	120.99	2
1	Nooksack	101.41	2
9	Duamish-Green	79.36	4
10	Puyallup	78.66	4
5	Stillaguamish	70.03	4
8	Cedar-Sammamish	49.04	6
25	Grays - Eloc.	46.38	6
21	Queets - Quinault	45.79	6
19	Lyre - Hoko	42.23	6
27	Lewis - Kalama	34.9	6
28	Salmon - Washougal	32.28	6
29	Wind - White Sal.	27.94	6
17	Quilcene	22.18	6
12	Chambers-Clover	20.65	6
18	Elwha - Dungeness	18.18	6
23	Upper Chehalis	10.95	6
15	Kitsap	10.3	6
3	Lower Skagit - Samis	4.23	8
13	Deschutes	3.45	8
11	Nisqually	1.71	8
2	San Juan	0	10
4	Upper Skagit	0	10
6	Island	0	10
14	Kennedy-Goldsbgh.	0	10
16	Hood Canal	0	10



II.1.g. SSRS PRIORITIZATION - TOTAL AGRICULTURAL USE - % OF WRIA

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

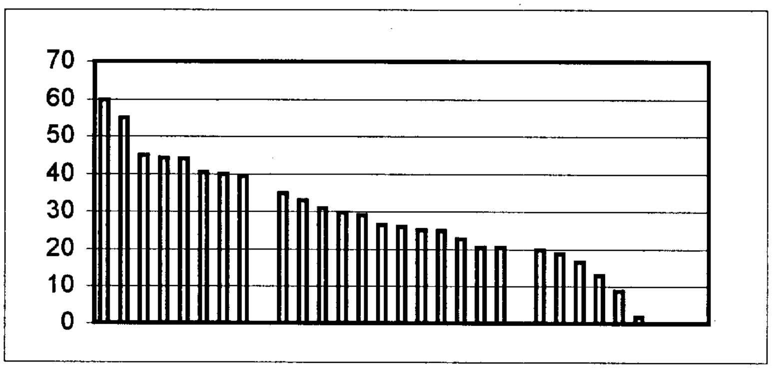
WRIA		Value	Score
3	Lower Skagit - Samish	18.8	0
28	Salmon - Washougal	14	0
1	Nooksack	13	0
23	Upper Chehalis	13	0
11	Nisqually	6.3	5
9	Duamish-Green	6.2	5
13	Deschutes	6.2	5
5	Stillaguamish	5.6	5
6	Island	5.6	5
7	Snohomish	4.4	5
2	San Juan	4.3	5
25	Grays - Eloc.	4.3	5
26	Cowlitz	4	5
18	Elwha - Dungeness	3.8	5
10	Puyallup	3.7	5
27	Lewis - Kalama	3.5	5
22	Lower Chehalis	3.3	5
12	Chambers-Clover	3	5
24	Willapa	2.6	5
29	Wind - White Sal.	2.4	5
17	Quilcene	1.7	10
14	Kennedy-Goldsbgh.	1.3	10
15	Kitsap	0.9	10
8	Cedar-Sammamish	0.7	10
19	Lyre - Hoko	0.5	10
16	Hood Canal	0.4	10
4	Upper Skagit	0.3	10
20	Sol Duc - Hoh	0.3	10
21	Queets - Quinault	0	10



II.1.h. SSRS PRIORITIZATION - TOTAL FOREST COVER - MID AND LATE SERAL STAGE %

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

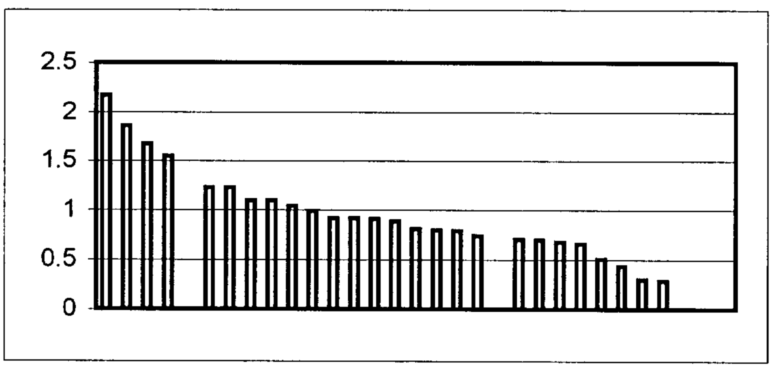
WRIA		Value	Score
16	Hood Canal	59.7	10
4	Upper Skagit	55	10
20	Sol Duc - Hoh	44.9	10
19	Lyre - Hoko	44.2	10
21	Queets - Quinault	44	10
10	Puyallup	40.39	10
15	Kitsap	40	10
18	Elwha - Dungeness	39.4	10
22	Lower Chehalis	34.89	5
24	Willapa	33.01	5
17	Quilcene	30.91	5
14	Kennedy-Goldsbgh.	29.76	5
7	Snohomish	29.01	5
27	Lewis - Kalama	26.5	5
5	Stillaguamish	26	5
11	Nisqually	25.11	5
13	Deschutes	24.9	5
8	Cedar-Sammamish	22.72	5
25	Grays - Eloc.	20.566	5
9	Duamish-Green	20.47	5
26	Cowlitz	19.75	0
28	Salmon - Washougal	18.856	0
23	Upper Chehalis	16.621	0
12	Chambers-Clover	12.9	0
1	Nooksack	8.67	0
3	Lower Skagit - Samis	1.63	0
2	San Juan		
6	Island		
29	Wind - White Sal.		



II.1.i. SSRS PRIORITIZATION - TOTAL STREAM GRADIENT - MILES < 4%/SQ.MILES DRAINAGE

Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

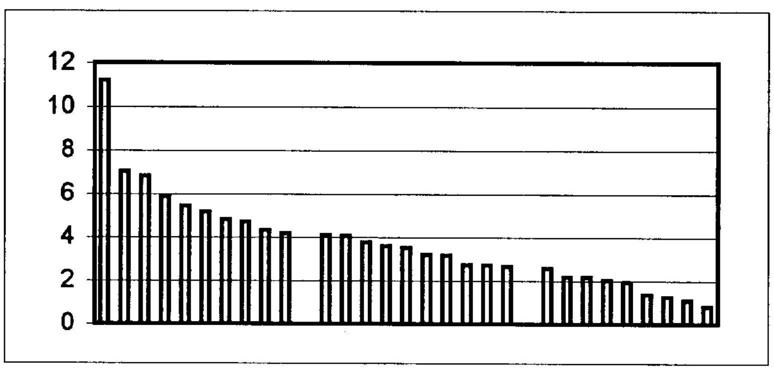
WRIA		Value	Score
24	Willapa	2.17	10
22	Lower Chehalis	1.86	10
23	Upper Chehalis	1.67	10
25	Grays - Eloc.	1.54	10
3	Lower Skagit - Samis	1.23	5
21	Queets - Quinault	1.23	5
15	Kitsap	1.1	5
20	Sol Duc - Hoh	1.1	5
14	Kennedy-Goldsbgh.	1.04	5
11	Nisqually	0.99	5
5	Stillaguamish	0.92	5
7	Snohomish	0.92	5
13	Deschutes	0.91	5
26	Cowlitz	0.89	5
1	Nooksack	0.81	5
19	Lyre - Hoko	0.8	5
28	Salmon - Washougal	0.79	5
27	Lewis - Kalama	0.74	5
8	Cedar-Sammamish	0.71	0
17	Quilcene	0.7	0
9	Duamish-Green	0.68	0
10	Puyallup	0.66	0
18	Elwha - Dungeness	0.51	0
16	Hood Canal	0.44	0
12	Chambers-Clover	0.3	0
4	Upper Skagit	0.29	0
2	San Juan		
6	Island		
29	Wind - White Sal.		



II.1.j. SSRS PRIORITIZATION - TOTAL ROAD MILES PER SQ. MILES IN WRIA

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Score
12	Chambers-Clover	11.21	0
8	Cedar-Sammamish	7.02	0
9	Duamish-Green	6.81	0
13	Deschutes	5.89	0
23	Upper Chehalis	5.45	0
25	Grays - Eloc.	5.19	0
11	Nisqually	4.84	0
14	Kennedy-Goldsbgh.	4.7	0
10	Puyallup	4.34	0
27	Lewis - Kalama	4.19	0
26	Cowlitz	4.09	5
24	Willapa	4.07	5
15	Kitsap	3.77	5
22	Lower Chehalis	3.6	5
28	Salmon - Washougal	3.51	5
29	Wind - White Sal.	3.2	5
3	Lower Skagit - Samis	3.17	5
7	Snohomish	2.72	5
5	Stillaguamish	2.71	5
20	Sol Duc - Hoh	2.67	5
17	Quilcene	2.58	10
21	Queets - Quinault	2.18	10
16	Hood Canal	2.17	10
1	Nooksack	2.01	10
19	Lyre - Hoko	1.94	10
18	Elwha - Dungeness	1.39	10
6	Island	1.26	10
4	Upper Skagit	1.08	10
2	San Juan	0.82	10



II.1.k. SSRS PRIORITIZATION - HYDROLOGIC MODIFICATION

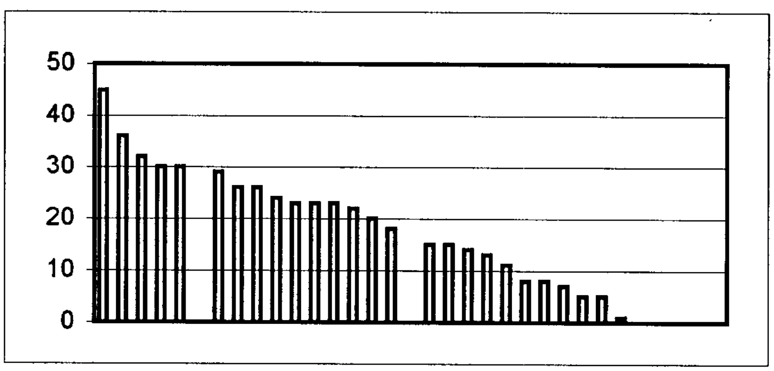
Category	Y-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Hydrologic Modification - Dams
1	Nooksack	10
5	Stillaguamish	10
6	Island	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
22	Lower Chehalis	10
24	Willapa	10
7	Snohomish	5
2	San Juan	5
3	Lower Skagit - Samish	5
4	Upper Skagit	5
9	Duamish-Green	5
10	Puyallup	5
12	Chambers-Clover	5
13	Deschutes	5
14	Kennedy-Goldsbgh.	5
15	Kitsap	5
17	Quilcene	5
18	Elwha - Dungeness	5
23	Upper Chehalis	5
25	Grays - Eloc.	5
28	Salmon - Washougal	5
16	Hood Canal	5
8	Cedar-Sammamish	0
11	Nisqually	0
26	Cowlitz	0
27	Lewis - Kalama	0
29	Wind - White Sal.	0

II.1.I SSRS PRIORITIZATION - TOTAL BARRIER CULVERTS ON D.O.T. ROADS PER WRIA

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Score
20	Sol Duc - Hoh	45	0
1	Nooksack	36	0
24	Willapa	32	0
5	Stillaguamish	30	0
15	Kitsap	30	0
21	Queets - Quinault	29	5
19	Lyre - Hoko	26	5
26	Cowlitz	26	5
3	Lower Skagit - Samis	24	5
8	Cedar-Sammamish	23	5
14	Kennedy-Goldsbgh.	23	5
22	Lower Chehalis	23	5
11	Nisqually	22	5
27	Lewis - Kalama	20	5
7	Snohomish	18	5
10	Puyallup	15	10
23	Upper Chehalis	15	10
25	Grays - Eloc.	14	10
16	Hood Canal	13	10
29	Wind - White Sal.	11	10
17	Quilcene	8	10
18	Elwha - Dungeness	8	10
28	Salmon - Washougal	7	10
4	Upper Skagit	5	10
9	Duamish-Green	5	10
13	Deschutes	1	10
12	Chambers-Clover	0	10
2	San Juan		
6	Island		



II.2.a. SSRS PRIORITIZATION - TOTAL WATER AVAILABLE FOR FISH

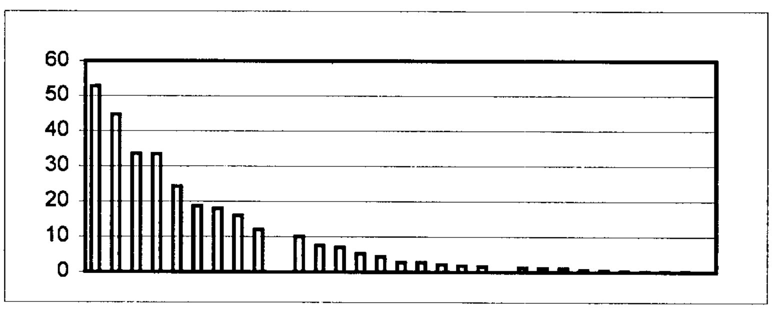
Category	X-axis points
I - Over appropriated	0
II - No instream flow set; water available	10
III - Unknown adequacy	5
IV - No instream flow set; high pressure	0
V - No instream flow set; low pressure	10

WRIA		Score
4	Upper Skagit	10
11	Nisqually	10
14	Kennedy-Goldsbgh.	10
16	Hood Canal	10
19	Lyre - Hoko	10
20	Sol Duc - Hoh	10
21	Queets - Quinault	10
24	Willapa	10
25	Grays - Eloc.	10
29	Wind - White Sal.	10
2	San Juan	5
3	Lower Skagit - Samish	5
5	Stillaguamish	5
6	Island	5
13	Deschutes	5
22	Lower Chehalis	5
23	Upper Chehalis	5
1	Nooksack	0
7	Snohomish	0
8	Cedar-Sammamish	0
9	Duamish-Green	0
10	Puyallup	0
12	Chambers-Clover	0
15	Kitsap	0
17	Quilcene	0
18	Elwha - Dungeness	0
26	Cowlitz	0
27	Lewis - Kalama	0
28	Salmon - Washougal	0

II.3 a. SSRS PRIORITIZATION - TOTAL % PROTECTED LANDS IN WRIA

Category	X-axis points
Favorable	10
Medium	5
Unfavorable	0

WRIA		Value	Score
4	Upper Skagit	52.7	10
18	Elwha - Dungeness	44.7	10
21	Queets - Quinault	33.5	10
20	Sol Duc - Hoh	33.4	10
10	Puyallup	24.2	10
16	Hood Canal	18.6	10
7	Snohomish	18	10
1	Nooksack	16	10
26	Cowlitz	12	10
5	Stillaguamish	10.1	5
11	Nisqually	7.5	5
29	Wind - White Sal.	7	5
19	Lyre - Hoko	5.2	5
17	Quilcene	4.3	5
8	Cedar-Sammamish	2.7	5
28	Salmon - Washougal	2.7	5
27	Lewis - Kalama	2.2	5
2	San Juan	1.8	5
3	Lower Skagit - Samish	1.6	5
22	Lower Chehalis	1.3	0
6	Island	1.2	0
24	Willapa	1.1	0
9	Duamish-Green	0.7	0
13	Deschutes	0.5	0
12	Chambers-Clover	0.3	0
15	Kitsap	0.3	0
14	Kennedy-Goldsbgh.	0.2	0
23	Upper Chehalis	0.2	0
25	Grays - Eloc.	0.1	0



Appendix 3

Scoring matrix by Water Resource Inventory Area (WRIA)

Summary of Ecosystem and Salmonid Scores

WRIA	Ecosystem X Axis Score	Ecosystem Y Axis Score	Salmonid X Axis Score	Salmonid Y Axis Score	Total X	Total Y
1 Nooksack	27	45	15	30	42	75
2 San Juan	50	35	20	30	70	65
3 Low Skag & Samish	43	20	20	50	63	70
4 Upper Skagit	90	20	25	55	115	75
5 Stillaguamish	39	40	20	55	59	95
6 Island	40	30	10	0	50	30
7 Snohomish	35	20	20	50	55	70
8 Cedar-Sammamish	36	0	15	35	51	35
9 Duamish-Green	29	5	15	20	44	25
10 Puyallup	39	10	20	30	59	40
11 Nisqually	43	30	20	40	63	70
12 Chambers-Clover	21	15	15	30	36	45
13 Deschutes	33	15	15	30	48	45
14 Kennedy-Golds	45	25	25	50	70	75
15 Kitsap	41	20	20	40	61	60
16 Skokomish-Dose	80	30	20	35	100	65
17 Quilcene	61	25	20	40	81	65
18 Elwha-Dungeness	56	30	10	35	66	65
19 Lyre Hoko	66	45	25	50	91	95
20 Sol Duc & Hoh	55	45	20	55	75	100
21 Queets Quinault	71	45	20	65	91	110
22 lower Chehalis	32	45	30	65	62	110
23 upper Chehalis	26	40	25	55	51	95
24 Willapa	37	40	15	45	52	85
25 Grays Eloc.	41	30	5	25	46	55
26 Cowlitz	32	20	5	20	37	40
27 Lewis Kalama	31	20	15	40	46	60
28 Salmon Washougal	26	15	15	40	41	55
29 Wind & White Sal	51	20	15	30	66	50

Prioritization Scores - Ecosystem

WRIA	Estuary II.1a	Marine Shoreline II.1.b	% Urban II.1.d	Channel Gradient II.1.i	Hydro Mod II.1.k	Y SUM	Forage Fish Abundance II.1.c	Growth II.1.e	Water Quality II.1.f	% Ag Use II.1.g	Forest Cover II.1.h	Road Density II.1.j	Fish Passage Barriers II.1.l	Water Availability II.2.a	Protected Lands II.3.a	X SUM
1 Nooksack	10	10	10	5	10	45	5	0	2	0	0	10	0	0	10	27
2 San Juan	10	10	10		5	35	5	10	10	5		10		5	5	50
3 Low Skag & Samish	0	5	5	5	5	20	10	5	8	0	0	5	5	5	5	43
4 Upper Skagit	0	5	10	0	5	20	10	10	10	10	10	10	10	10	10	90
5 Stillaguamish	10	5	10	5	10	40	5	5	4	5	5	5	0	5	5	39
6 Island	10	5	5		10	30	5	5	10	5		10		5	0	40
7 Snohomish	0	5	5	5	5	20	5	0	0	5	5	5	5	0	10	35
8 Cedar-Sammamish	0	0	0	0	0	0	5	0	6	10	5	0	5	0	5	36
9 Duamish-Green	0	0	0	0	5	5	5	0	4	5	5	0	10	0	0	29
10 Puyallup	0	0	5	0	5	10	0	0	4	5	10	0	10	0	10	39
11 Nisqually	10	5	10	5	0	30	0	5	8	5	5	0	5	10	5	43
12 Chambers-Clover	5	5	0	0	5	15	0	0	6	5	0	0	10	0	0	21
13 Deschutes	0	5	0	5	5	15	0	0	8	5	5	0	10	5	0	33
14 Kennedy-Golds	5	5	5	5	5	25	0	5	10	10	5	0	5	10	0	45
15 Kitsap	5	5	0	5	5	20	10	0	6	10	10	5	0	0	0	41
16 Skokomish-Dose	10	5	10	0	5	30	0	10	10	10	10	10	10	10	10	80
17 Quilcene	5	5	10	0	5	25	10	5	6	10	5	10	10	0	5	61
18 Elwha-Dungeness	5	10	10	0	5	30	0	5	6	5	10	10	10	0	10	56
19 Lyre Hoko	10	10	10	5	10	45	0	10	6	10	10	10	5	10	5	66
20 Sol Duc & Hoh	10	10	10	5	10	45	0	10	0	10	10	5	0	10	10	55
21 Queets Quinault	10	10	10	5	10	45	0	10	6	10	10	10	5	10	10	71
22 lower Chehalis	10	5	10	10	10	45	0	5	2	5	5	5	5	5	0	32
23 upper Chehalis	10	5	10	10	5	40	0	5	6	0	0	0	10	5	0	26
24 Willapa	5	5	10	10	10	40	0	10	2	5	5	5	0	10	0	37
25 Grays Eloc.	0	5	10	10	5	30	0	5	6	5	5	0	10	10	0	41
26 Cowlitz	0	5	10	5	0	20	0	5	2	5	0	5	5	0	10	32
27 Lewis Kalama	0	5	10	5	0	20	0	5	6	5	5	0	5	0	5	31
28 Salmon Washougal	0	5	0	5	5	15	0	0	6	0	0	5	10	0	5	26
29 Wind & White Sal	0	5	10	5	0	20	0	10	6	5		5	10	10	5	51

Prioritization Scores - Salmonids

WRIA	Healthy Stocks I.1.a	Stock Origin I.1.c	Production Type I.1.d	Stocks Overfished I.2.a	Hatchery Fish ID I.2.c	Natural Juvenile Production I.2.d	Hatchery-Natural Ratio I.2.e	Y Sum	Unhealthy Stocks I.1.b	Genetic Diversity I.1.e	Spawner Numbers I.2.b	X Sum
1 Nooksack	0	5	10	10	5	0	0	30	5	10	0	15
2 San Juan	0	0	10	10	5	0	5	30	10		10	20
3 Lower Skagit - Samish	5	0	10	10	5	10	10	50	5	10	5	20
4 Upper Skagit	0	10	10	10	5	10	10	55	10	10	5	25
5 Stillaguamish	5	10	10	10	5	5	10	55	5	10	5	20
6 Island	0					0	0	0	10			10
7 Snohomish	5	5	10	10	5	5	10	50	5	10	5	20
8 Cedar-Sammamish	0	0	10	10	5	10	0	35	5	10	0	15
9 Duamish-Green	5	0	0	5	5	5	0	20	10	5	0	15
10 Puyallup	5	5	5	5	5	5	0	30	10	10	0	20
11 Nisqually	0	10	10	5	5	5	5	40	10	10	0	20
12 Chambers-Clover	0	5	5	5	5	5	5	30	10	5	0	15
13 Deschutes	0	0	5	10	5	10	0	30	10	5	0	15
14 Kennedy-Goldsbgh.	5	10	10	10	5	5	5	50	10	10	5	25
15 Kitsap	5	5	5	5	5	10	5	40	5	10	5	20
16 Hood Canal	5	5	5	10	5	5	0	35	5	10	5	20
17 Quilcene	0	5	10	10	5	10	0	40	5	10	5	20
18 Elwha - Dungeness	0	5	5	10	5	10	0	35	0	10	0	10
19 Lyre - Hoko	5	5	10	10	5	10	5	50	10	10	5	25
20 Sol Duc - Hoh	10	10	10	10	5	0	10	55	5	10	5	20
21 Queets - Quinault	10	10	10	10	5	10	10	65	5	10	5	20
22 Lower Chehalis	10	5	10	10	10	10	10	65	10	10	10	30
23 Upper Chehalis	5	5	10	10	10	10	5	55	10	10	5	25
24 Willapa	5	10	10	0	10	5	5	45	10	5	0	15
25 Grays - Eloc.	0	5	5	0	10	5	0	25	0	5	0	5
26 Cowlitz	0	5	5	0	10	0	0	20	0	5	0	5
27 Lewis - Kalama	0	5	10	0	10	10	5	40	5	10	0	15
28 Salmon - Washougal	0	10	10	5	10	5	0	40	5	10	0	15
29 Wind - White Sal.	0	0	5	5	10	10	0	30	5	10	0	15
Sources	SRSS	SASSI	SASSI	WSP EIS	PFMC	WDFW	PFMC		SRSS	GDU	PFMC	

Appendix 4

Summary of results by Water Resource Inventory Area (WRIA)

This appendix provides a basic summary of information on ecosystem and salmonid scoring to aid interpretation of compiled scores for each Water Resource Inventory Area (WRIA). Narratives were prepared from inspection of the scores shown in Appendices 2 and 3. To orient readers, this appendix also identifies major cities or towns, and major river systems within each WRIA.

WRIA 1 - Nooksack

Cities: Bellingham
Major river systems: Nooksack River

Ecosystem Scoring:

The Nooksack WRIA received favorable ratings for intact estuarine and nearshore marine areas, amount of WRIA in protected land status (16 percent) and the low amount of WRIA area in urban development (3.9 percent). Low overall road density and low level of hydrological modification were also factors that rated favorably. Channel gradient and forage fish rated moderate. A number of factors rated poorly. These are: low percent of mid-to-late seral stage riparian areas along salmon streams (8.7 percent - one of the lowest levels for Western Washington), population growth, water quality, amount of WRIA in agricultural status (13 percent) and WSDOT fish passage barriers (36 - this is the second highest amount per WRIA in Western Washington). In addition water availability for fish rated poorly: Instream flows have been set but not enforced, water is overappropriated, and there is significant growth pressure and expected need for more water.

Salmonid Scoring:

The Nooksack WRIA received favorable ratings for production type, the low percentage of stocks overfished and genetic diversity present within and among salmonid populations in this WRIA. Unfavorable ratings occurred for total healthy stock significance, knowledge of natural juvenile production, the ratio of hatchery to natural production, and spawner numbers.

WRIA 2 - San Juan

Cities: No major cities.
Major river systems: None.

Ecosystem Scoring:

The San Juan WRIA has six factors that rated favorably, five medium and three with no data available. Especially important is the favorable rating for nearshore marine condition. Although the San Juan Islands do not have large freshwater spawning and rearing areas, the islands' nearshore habitats are of importance to salmonids originating in other WRIAs. Also with favorable ratings are estuary development, percent urban land use, population growth, water quality and road density. Hydrologic modification, forage fish, percent agricultural land use, water availability and protected lands rated medium. Gradient, seral stage along salmon streams, and WSDOT passage barriers were factors with no data to allow rating.

Salmonid Scoring:

The San Juan WRIA received favorable ratings for production type, low unhealthy stock status, the low percentage of stocks overfished, and sufficient spawner numbers within salmonid populations in this WRIA. Unfavorable ratings occurred for total healthy stock significance, stock origin, and knowledge of natural juvenile production. Data were not available to assess the importance of the genetic diversity contained within and among salmonid populations in this WRIA.

WRIA 3 - Lower Skagit - Samish

Cities: Mount Vernon
Major river systems: Lower portions of the Skagit River.

Ecosystem Scoring:

For the Lower Skagit and Samish WRIA, forage fish and water quality rated favorably. Nine of the fourteen factors rated medium (nearshore marine condition, percent urban land use (6.9), gradient, hydrologic modification, population growth, road density, WSDOT passage barriers (24), water availability (no instream flows, significant development pressure) and extent of protected lands (1.6 percent of WRIA). Factors that rated poorly are estuary development, amount of mid-to-late seral stage along salmon streams (1.6 percent), and percent agricultural land use (18.8). This WRIA has the lowest Western Washington percentage of mid-to-late seral stage along salmon streams. It also has the greatest Western Washington percent of land use in agriculture.

Salmonid Scoring:

The Lower Skagit and Samish WRIA received favorable ratings for production type, the low percentage of stocks overfished, knowledge of natural juvenile production, the ratio of hatchery to natural production, and genetic diversity present within and among salmonid populations in this WRIA. Unfavorable ratings occurred for only the stock origin measure.

WRIA 4 - Upper Skagit

Cities: No major cities.
Major river systems: Upper tributaries of the Skagit River.

Ecosystem Scoring:

Upper Skagit is one of the five Western Washington WRIAs with the highest/most favorable overall ecosystem scores. (The others are Hood Canal, Lyre-Hoko, Sol Duc-Hoh and Queets-Quinault.) Urban and agricultural areas of the Skagit watershed predominantly fall within WRIA 3. Upper Skagit favorable ratings are: percent urban (0.3) and percent agricultural land use (0.3), forage fish, population growth, water quality, amount of mid-to-late seral stage along salmon streams (55.0 percent), road density, WSDOT fish barriers (5), water availability (flows not set, limited growth), and amount of land in protected status (52.7 percent). Nearshore marine condition and hydrologic modification are rated medium. Estuary development (from Lower Skagit) and channel gradient are rated unfavorably.

Salmonid Scoring:

The Lower Skagit WRIA received many favorable ratings. These included: stock origin, production type, the low percentage of stocks overfished, knowledge of natural juvenile production, the ratio of hatchery to natural production, total unhealthy stock significance, and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for only the total healthy stock significance measure.

WRIA 5 - Stillaguamish

Cities: Arlington
Major river systems: Stillaguamish River

Ecosystem Scoring:

Estuary development, percent urban land use (3.1) and hydrologic modification are rated favorably. Ten factors rated medium. They are: nearshore marine condition, channel gradient, forage fish, population growth, water quality, percent land use in agriculture (5.6), forest seral stage along salmon streams (26), road density, water availability (flows not set, growth pressure) and amount of WRIA in protected land status (10.1 percent). Only one factor rated poorly. This is fish passage at WSDOT sites (30 sites in this WRIA).

Salmonid Scoring:

The Stillaguamish WRIA received many favorable ratings. These included: stock origin, production type, the low percentage of stocks overfished, the ratio of hatchery to natural production, and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred.

WRIA 6 - Island

Cities: No major cities.
Major river systems: None.

Ecosystem Scoring:

As with the San Juan WRIA, a major importance of the Island WRIA to salmon protection and recovery is for its nearshore habitat. Factors rating favorably are: estuary development, hydrologic modification, water quality and road density. Medium rated factors are: nearshore marine condition, urban land use percent, forage fish, population growth, agricultural land use percent and water availability. Amount of protected land rated poorly. Three factors were not able to be rated due to lack of data. They are: gradient, seral stage along salmon streams, and WSDOT passage barriers.

Salmonid Scoring:

The Island WRIA is a very minor producer of salmonids due to the natural lack of suitable spawning and freshwater rearing habitat. There was not any information on many salmonid scoring measures. The only favorable rating was the unhealthy stock significance.

WRIA 7 - Snohomish

Cities: Everett
Major river systems: Snohomish, Skykomish, and Snoqualmie Rivers.

Ecosystem Scoring:

Most factors (nine of fourteen) rated medium. These are: nearshore marine condition, percent of WRIA in urban condition (5.6), channel gradient, hydrologic modification, forage fish abundance, percentage of land in agricultural use (4.4), forest seral stage along salmon streams (29.0 percent in mid-to-late seral stages), road density and WSDOT passage barriers. Protected lands rated favorably (18 percent of WRIA). Unfavorable ratings were for estuary development, population growth, water quality and water availability (overappropriated and instream flows are often not met).

Salmonid Scoring:

The Snohomish WRIA received favorable ratings for production type, the low percentage of stocks overfished, the ratio of hatchery to natural production, and the genetic diversity present within and among salmonid populations. No unfavorable ratings occurred for salmonid factors in this WRIA.

WRIA 8 - Cedar-Sammamish

Cities: Seattle and Edmonds
Major river systems: Lakes Washington and Sammamish and the Cedar River

Ecosystem Scoring:

This is one of three WRIAs with poorest total ecosystem scores. The Green-Duwamish and Chambers-Clover also had poor total scores. Driving this score for the Cedar-Sammamish are unfavorable ratings for eight of the fourteen factors. They are: estuary development, nearshore marine condition, percent urban land use (38.9), gradient, hydromodification, population growth, road density (7.02 road miles per square mile) and water availability (overappropriated). Medium scores are for: forage fish, water quality, seral stage along salmon streams, WSDOT passage barriers (23) and amount of land in protected status (2.7 percent). Amount of agricultural land use rated favorably.

Salmonid Scoring:

The Cedar-Sammamish WRIA received favorable ratings for production type, the low percentage of stocks overfished, knowledge of natural juvenile production, and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for the total healthy stock significance, stock origin, high ratio of hatchery to wild production, and spawner numbers.

WRIA 9 - Green-Duwamish

Cities: Kent and Federal Way
Major river systems: Green River

Ecosystem Scoring:

The Green-Duwamish WRIA has the poorest total ecosystem score for the Western Washington WRIAs. As with WRIA 8, this is driven by unfavorable ratings for eight of the fourteen factors. These factors are: estuary development, nearshore marine condition, percent urban land use (23.6), gradient, population growth, road density (6.8 road miles per square mile), water availability (overappropriated) and amount of protected lands (0.7 percent). Hydrologic modification, forage fish, water quality, percent agricultural land use and mid-to-late seral stage along salmon streams rate medium. One factor, WSDOT passage barriers rates favorably.

Salmonid Scoring:

The Duamish-Green WRIA received favorable ratings for only the total unhealthy stock significance. production type, the low percentage of stocks overfished, knowledge of natural juvenile production, and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for, stock origin, production type, high ratio of hatchery to wild production, and spawner numbers.

WRIA 10 - Puyallup

Cities: Tacoma, Sumner and Puyallup
Major river systems: Puyallup River

Ecosystem Scoring:

The Puyallup WRIA has three factors which rate favorably. These are: forest seral stage along salmon streams (40.4 percent is in mid-to-late seral stages), WDSOT barriers (15) and protected lands (24.2 percent of the WRIA). Four factors are in the medium category: percent of land use in urban development (9.4), and agricultural (3.7 percent), hydrologic modification and water quality. One half of all factors (seven) are rated unfavorably. They are: estuary development, nearshore marine condition, forage fish, population growth, channel gradient, road density and water availability (overappropriated, low flows declining due to water use and land use changes).

Salmonid Scoring:

The Puyallup WRIA received favorable ratings for the total unhealthy stock significance and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for the high ratio of hatchery to wild production, and spawner numbers.

WRIA 11 - Nisqually

Cities: Fort Lewis Army Base
Major river systems: Nisqually River

Ecosystem Scoring:

The Nisqually received favorable ratings for low level of estuary development, urban development (2.9 percent of WRIA in this land use), water quality and water availability (flows are set, but adequacy is unknown, low to moderate growth pressure). Seven factors rated medium. They are nearshore marine condition, gradient, population growth, percent agricultural use (6.3 percent of WRIA), seral stage along salmon streams (25.1 percent in mid-to-late seral stage), fish passage at WSDOT sites (22 sites), and amount of land in protected status (7.5 percent of WRIA). Hydrologic modification, forage fish and road density are factors that rated poorly.

Salmonid Scoring:

The Nisqually WRIA received favorable ratings for stock origin, production type, unhealthy stock significance and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for total healthy stock significance and spawner numbers.

WRIA 12 - Chambers-Clover

Cities: Tacoma and takes in McChord Air Force Base.
Major river systems: Chambers and Clover Creeks, but no major rivers.

Ecosystem Scoring:

The total ecosystem score for this WRIA placed it among the three WRIAs with the poorest ecosystem scores. Others with the same or similar scores are the Cedar-Sammamish and Duwamish-Green. Chambers-Clover WRIA is smaller than most, and does not include a large upper watershed giving it a more pronounced evaluation of it's urbanized features. At the WRIA scale that this rating is being accomplished for, larger WRIAs tend to have a score that blends their urbanized characteristics with upper watershed less developed characteristics. This is not the case for WRIA 12.

WSDOT barriers are rated favorably. This is the only Western Washington WRIA with no WSDOT fish passage barriers. Estuary development, nearshore marine condition, hydrologic modification, water quality and percent agricultural land use (3) all rated medium. Poor ratings are for: percent urban land use (48.3 - the highest of all Western Washington WRIAs), gradient, forage fish, population growth, forest mid-to-late seral stage along salmon streams (12.9 percent), road density, water availability (overappropriated) and amount of watershed in protected land status (0.3 percent).

Salmonid Scoring:

The Chambers-Clover WRIA received favorable ratings for only unhealthy stock significance. and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for total healthy stock significance and spawner numbers.

WRIA 13 - Deschutes

Cities: Olympia
Major river systems: Deschutes River

Ecosystem Scoring:

Two factors for the Deschutes WRIA rated favorably. These are water quality and WSDOT fish passage barriers. All other factors rated either medium or unfavorably. Medium factors are nearshore marine condition, amount of channel with less than four percent gradient, hydrologic modification, amount of WRIA in agricultural use (6.2 percent), mid-late seral stage forest along salmon streams (24.9 percent) and water availability (no instream flows have been set, flow adequacies are unknown, and there is high growth pressure). Factors with unfavorable ratings are: percent urban land use, estuary development, forage fish abundance, population growth, road density and protected lands.

Salmonid Scoring:

The Deschutes WRIA received favorable ratings for stocks overfished and knowledge of natural juvenile production, unhealthy stock significance and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for total healthy stock significance, stock origin (because the anadromous salmonid populations were started from nonlocal hatchery strains after fish ladders were built at natural blockages at the mouth of the stream), hatchery-natural ratio and spawner numbers.

WRIA 14 - Kennedy-Goldsborough

Cities: Shelton
Major river systems: Goldsborough and Kennedy Creeks

Ecosystem Scoring:

Eight of fourteen factors rated medium. They are: estuary development, nearshore marine condition, percent urban development (7), channel gradient, hydrologic modification, population growth, mid-to-late seral stage along salmon streams (29.7 percent), and WSDOT passage barriers (23). Water quality, percent agricultural land use, and water availability rated favorable. Forage fish, road density and amount of protected lands (0.2 percent) have unfavorable ratings.

Salmonid Scoring:

The Kennedy-Goldsborough WRIA received favorable ratings for stock origin, production type, stocks overfished, unhealthy stock significance and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred.

WRIA 15 - Kitsap

Cities: Bremerton
Major river systems: many small tributaries such as Minter Creek, Big Beef Creek, Dewatto River, Union River, Mission Creek, and Tahuya River

Ecosystem Scoring:

Kitsap WRIA has favorable ratings for forage fish (this represents the highest Western Washington rating), percent agricultural land use and amount of mid-to-late seral stage along salmon streams (40.0 percent). Factors with medium ratings are: estuary development, nearshore marine condition, channel gradient, hydrologic modification, water quality and road density. Percent urban development (12.5), population growth, WSDOT passage barriers (30), water availability and amount of protected lands (0.3 percent) have unfavorable ratings.

Salmonid Scoring:

The Kitsap WRIA received favorable ratings for knowledge of juvenile natural production and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred. Many scores were average, in part because this WRIA contains many streams that flow east into western Puget Sound and also many streams that flow west into eastern Hood Canal. The fish management practices and their impacts on salmonids have differed among the watersheds.

WRIA 16 - Hood Canal

Cities: Port Townsend
Major river systems: Skokomish, Hamma Hamma, Duckabush, and the Dosewallips River

Ecosystem Scoring:

Hood Canal WRIA is among the five Western Washington WRIAs with highest overall ecosystem scores. (The others are Upper Skagit, Lyre-Hoko, Sol Duc-Hoh and Queets-Quinault.) Ten of fourteen factors rated favorable. They are: estuary development, percent urban development (1), population growth, water quality, percent agricultural land use, mid-to-late seral stage along salmon streams (59.7 percent, this is the highest Western Washington value), road density, WSDOT passage barriers (13), water availability and amount of protected lands (18.6 percent). Factors with medium ratings are nearshore marine condition and hydrologic modification. Channel gradient and forage fish have unfavorable ratings.

Salmonid Scoring:

The Hood Canal WRIA received favorable ratings for stocks overfished and genetic diversity present within and among salmonid populations. The only unfavorable rating occurred for the ratio of hatchery to natural production.

WRIA 17 - Quilcene

Cities: town of Quilcene
Major river systems: Quilcene River and Snow Creek

Ecosystem Scoring:

Factors with favorable ratings are: percent urban development (3.1), forage fish, percent agricultural land use, road density and WSDOT passage barriers (8). One half of all factors are rated medium. They are: estuary development, nearshore marine condition, hydrologic modification, population growth, water quality, mid-to-late seral stage along salmon streams (30.9 percent), and amount of protected lands (4.3 percent). Channel gradient and water availability (overappropriated) have unfavorable ratings.

Salmonid Scoring:

The Quilcene WRIA received favorable ratings for production type, the low percentage of stocks overfished, knowledge of natural juvenile production, total unhealthy stock significance, and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for the total healthy stock significance and the ratio of hatchery to natural production measures.

WRIA 18 - Elwha-Dungeness

Cities: Port Angeles and Sequim
Major river systems: Elwha and Dungeness Rivers

Ecosystem Scoring:

Most factors in the Elwha-Dungeness WRIA were rated favorably or medium with only three of the fourteen factors rated unfavorable. Nearshore marine condition, percent urban area (1.6), mid-to-late seral stage along salmon streams (39.4 percent), road density, fish passage (WSDOT), and amount of watershed in protected status (44.7 percent) were all rated favorably. Water availability was among factors with poor ratings. In the Dungeness flows are overappropriated and instream flow rules are underway.

Salmonid Scoring:

The Elwha-Dungeness WRIA received favorable ratings for the low percentage of stocks overfished, knowledge of natural juvenile production, and genetic diversity present within and among salmonid populations. Unfavorable ratings occurred for the total healthy stock significance, the ratio of hatchery to natural production, total unhealthy stock significance, and spawner numbers.

WRIA 19 - Lyre-Hoko

Cities: No major cities.
Major river systems: Lyre, Sekieu, and Hoko Rivers

Ecosystem Scoring:

Lyre-Hoko is one of the five Western Washington WRIAs with highest overall ecosystem scores. The others are Upper Skagit, Hood Canal, Sol Duc-Hoh and Queets-Quinault. Only forage fish rated unfavorably. Gradient, water quality, WSDOT fish passage (26 sites) and amount of WRIA in protected status (5.3 percent) rated medium. All other factors (nine), rated favorably. These are: estuary development, nearshore marine condition, percent urban land use, hydromodification, population growth, percent agricultural land use, mid-to-late seral stage along salmon streams (44.2 percent), road density and water availability.

Salmonid Scoring:

The Lyre-Hoko WRIA received favorable ratings for production type, the low percentage of stocks overfished, knowledge of natural juvenile production, total unhealthy stock significance, and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred.

WRIA 20 - Sol Duc-Hoh

Cities: town of Forks
Major river systems: Quilleyute, Sol Duc, Bogachiel, and Hoh Rivers

Ecosystem Scoring:

Sol Duc-Hoh is one of the five Western Washington WRIAs with highest overall ecosystem scores. The others are Upper Skagit, Hood Canal, Lyre-Hoko, and Queets-Quinault. Forage fish rated unfavorably as did WSDOT barrier sites. This WRIA has 45 locations which is the greatest number within any Western Washington WRIA. In addition, water quality rated unfavorably with the greatest Western Washington value for amount of stream miles on the state impaired water quality list for stream temperature and/or dissolved oxygen. Gradient and road density are factors that rated medium. All other factors (nine) rated favorably. They are: estuary development, nearshore marine condition, percent urban land use, hydromodification, population growth, percent agricultural land use, mid-to-late seral stage along salmon streams (44.9 percent), water availability and amount of WRIA in protected land status (33.4 percent).

Salmonid Scoring:

The Sol Duc-Hoh WRIA received many favorable ratings: total healthy stock significance, stock origin, production type, the low percentage of stocks overfished, the ratio of hatchery to natural production, and genetic diversity present within and among salmonid populations. An unfavorable rating occurred for the knowledge of juvenile production.

WRIA 21 - Queets Quinault

Cities: No major cities.
Major river systems: Queets and Quinault Rivers

Ecosystem Scoring:

Queets-Quinault had the highest overall ecosystem score of the Western Washington WRIAs. Ten factors rated favorably. These are: estuary development, nearshore marine condition, percent urban land use, hydromodification, population growth, percent agricultural land use, mid-to-late seral stage along salmon streams (44.0 percent), road density, water availability and amount of WRIA in protected land status (33.5 percent). Gradient, water quality and WSDOT passage barriers (29) rated medium. Forage fish rated unfavorably.

Salmonid Scoring:

The Queets-Quinault WRIA received many favorable ratings: total healthy stock significance, stock origin, production type, the low percentage of stocks overfished, the ratio of hatchery to natural production, knowledge of natural juvenile production, and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred.

WRIA 22 - Lower Chehalis

Cities: Aberdeen and Hoquiam
Major river systems: Chehalis, Wynochee, and Satsop Rivers

Ecosystem Scoring:

The Lower Chehalis has four favorable ratings, seven medium and three unfavorable. Estuary development level, percent urban land use, gradient and hydrologic modification are factors that rated as favorable. Nearshore marine condition, population growth, percent agricultural land use (3.3 percent), forest seral stage along salmon streams (34.9 percent of these riparian areas are in mid-to-late seral stages), road density, WSDOT barrier sites (23) and water availability rated medium. Forage fish, water quality and amount of WRIA in protected land status (1.3 percent) rated unfavorably.

Salmonid Scoring:

The Lower Chehalis WRIA received many favorable ratings. Only one rating was in the medium class – stock origin. This was the WRIA that received the greatest number of favorable scores.

WRIA 23 - Upper Chehalis

Cities: Centralia and Chehalis
Major river systems: Chehalis River

Ecosystem Scoring:

Upper Chehalis scores were evenly distributed between favorable, medium and unfavorable ratings. Factors rating favorable are: estuary development, percent urban land use, gradient and WSDOT barrier sites (15). Nearshore marine condition, hydrologic modification, population growth, water quality and water availability rated medium. Forage fish, percent agricultural land use (13), forest seral stage along salmon streams (16.6 percent in mid-to-late seral stages), road density and amount of WRIA in protected land status (0.2 percent) rated poorly.

Salmonid Scoring:

The Upper Chehalis WRIA received many favorable ratings: production type, the low percentage of stocks overfished, identification of hatchery production, knowledge of natural juvenile production, total unhealthy stock significance, and genetic diversity present within and among salmonid populations. No unfavorable ratings occurred.

WRIA 24 - Willapa

Cities: No major cities.
Major river systems: North, Willapa, and Nemah Rivers

Ecosystem Scoring:

Percent urban land use, gradient, hydrologic modification, population growth and water availability rated favorably. Estuary development, nearshore marine condition, percent agricultural land use (2.6 percent), forest seral stage along salmon streams and road density rated medium. Forage fish, water quality, WSDOT barrier sites (32, one of the highest numbers of barriers in Western Washington) and amount of WRIA in protected land status (1.1 percent) rated poorly.

Salmonid Scoring:

The Willapa WRIA received favorable ratings for stock origin, production type, identification of hatchery production, and total unhealthy stock significance. Unfavorable ratings occurred for the number of stocks overfished and spawner numbers.

WRIA 25 - Grays-Elochoman

Cities: no major cities.
Major river systems: Grays and Elochoman Rivers feed into the Columbia River.

Ecosystem Scoring:

This WRIA has four factors rated favorably, six medium, and four unfavorably. Those rated favorable are: amount of WRIA in urban land use (3.7 percent), channel gradient, low WSDOT fish passage barrier amount, and water availability (flows not set, studies underway, limited development pressure). Medium rated factors are nearshore marine condition, hydrologic modification, population growth, water quality, amount of WRIA in agricultural land use (4.3 percent), and seral stage of forests along salmon streams (20.6 percent mid to late seral stage). Those factors with poor ratings are estuary development (Columbia River estuary), forage fish abundance, road density (5.19 miles per square mile in the WRIA), and amount of protected lands (0.1 percent).

Salmonid Scoring:

The Grays-Elochoman WRIA received a favorable rating for identification of hatchery production, but had unfavorable ratings for total healthy stock significance, stocks overfished, high ratio of hatchery to wild production, total unhealthy stock significance, and spawner numbers.

WRIA 26 - Cowlitz

Cities: Longview and Kelso
Major river systems: Cowlitz, Toutle, and Coweeman Rivers feed into the Columbia River.

Ecosystem Scoring:

The amount of the Cowlitz WRIA in urban land use (1.3 percent), and the amount in protected status (12 percent) received favorable ratings. Nearshore marine condition, gradient, population growth, percent of WRIA in agricultural land use, road density and WSDOT passage barriers have medium ratings. Unfavorable ratings are for: estuary development (Columbia River), hydrologic modification, forage fish, water quality, amount of mid-to-late seral stage forest along salmon streams (19.8 percent), and water availability (no instream flows, significant development pressure).

Salmonid Scoring:

The Cowlitz WRIA received a favorable rating for identification of hatchery production, but had unfavorable ratings for total healthy stock significance, stocks overfished, knowledge of natural juvenile production, high ratio of hatchery to wild production, total unhealthy stock significance, and spawner numbers.

WRIA 27 - Lewis-Kalama

Cities: no major cities.
Major river systems: Lewis and Kalama Rivers feed into the Columbia River.

Ecosystem Scoring:

The level of urban land use rated favorable for this WRIA. All other factors were rated medium or unfavorable. Nearshore marine condition, gradient, population growth, water quality, percent of WRIA in agricultural land use, amount of mid-to-late seral stage forest along salmon streams (26.5 percent), WSDOT passage barriers and amount of WRIA in protected status have medium ratings. Estuary development (Columbia River), hydrologic modification, forage fish, road density and water availability (no instream flows, significant development pressure) rated poorly.

Salmonid Scoring:

The Lewis-Kalama WRIA received favorable ratings for production type, identification of hatchery production, knowledge of natural production, and genetic diversity. Unfavorable ratings occurred for the total healthy stock significance, the number of stocks overfished and spawner numbers.

WRIA 28 - Salmon-Washougal

Cities: Vancouver and Camas
Major river systems: Salmon Creek and the Washougal River feed into the Columbia River.

Ecosystem Scoring:

WSDOT fish barriers rated favorably (seven locations). Nearshore marine condition, gradient, hydrologic modification, water quality, and the amount of the WRIA in protected status are rated medium.. Unfavorable ratings are for: estuary development (Columbia River), urban land use (22.6 percent of the WRIA), forage fish, population growth, agricultural land use (14 percent - the second highest percent for a Western Washington WRIA), amount of mid-to-late seral stage forest along salmon streams (18.8 percent), road density WDOT passage barriers and water availability (no instream flows, significant development pressure).

Salmonid Scoring:

The Salmon-Washougal WRIA received favorable ratings for stock origin, production type, identification of hatchery production, and genetic diversity. Unfavorable ratings occurred for the total healthy stock significance, the high ratio of hatchery to natural production, and spawner numbers.

WRIA 29 - Wind-White Salmon

Cities: no major cities.
Major river systems: Wind and White Salmon Rivers feed into the Columbia River.

Ecosystem Scoring:

Percent of WRIA in urban development (1.1), population growth, WSDOT passage barriers, and water availability are factors that rated favorably. Medium factors are: nearshore marine condition, channel gradient, water quality, percent of WRIA in agricultural use (2.4), road density, and amount of WRIA in protected land status (7 percent). Estuary development and marine forage fish abundance (Columbia estuary ratings used for both of these factors) rated poorly as did hydrologic modification. Data did not exist to rate the percent of salmon stream with mid-to-late seral stage riparian area. Note that the lack of this rating does not affect the location on the expected efficiency axis.

Salmonid Scoring:

The Wind-White Salmon WRIA received favorable ratings for identification of hatchery production, knowledge of natural juvenile production and genetic diversity. Unfavorable ratings occurred for the total healthy stock significance, stock origin, the high ratio of hatchery to natural production, and spawner numbers.