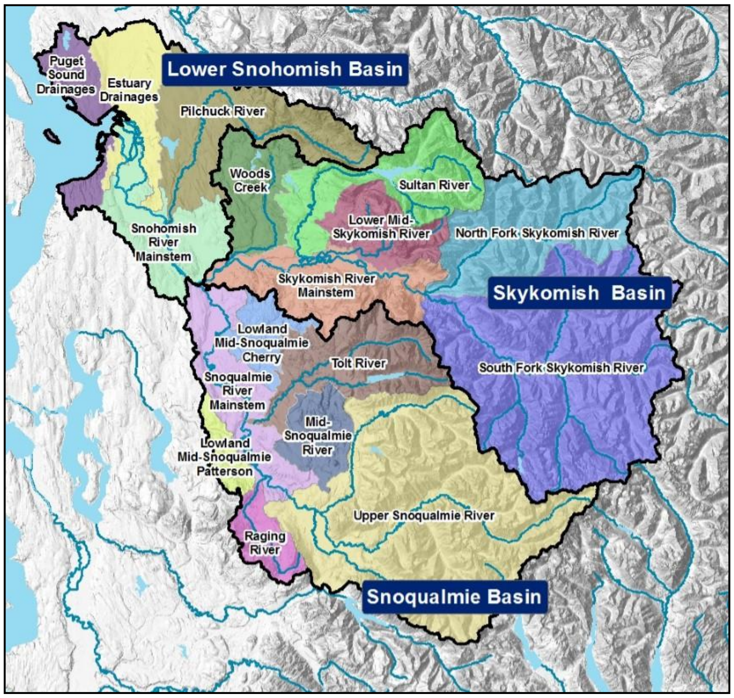



# Watershed Characterization for WRIA 7

## Assessment and Recommendations for Protection of Water Flow Processes

March 2015
Publication No. 15-06-009

DEPARTMENT OF ECOLOGY
State of Washington

## Publication and Contact Information

This report is available on the Department of Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/1506009.html

For more information contact:

Shorelands and Environmental Assistance Program
P.O. Box 47600
Olympia, WA 98504-7600

Phone: 360-407-6908

Washington State Department of Ecology - www.ecy.wa.gov

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

This project has been funded wholly or in part by the United States Environmental Protection Agency under Puget Sound Ecosystem Restoration and Protection Cooperative Agreement grant PC-00J20101 With Washington Department of Ecology. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Preferred Citation:

Hume, C., Wilhere, G., Stanley, S., Grigsby, S., and Slattery, K. 2015. Watershed Characterization for WRIA 7: Assessment and Recommendations for Protection of Water Flow Processes. Shorelands and Environmental Assistance Program, Washington Department of Ecology. Olympia, WA. Publication # 15-06-009.

# Watershed Characterization for WRIA 7

## Assessment and Recommendations for Protection of Water Flow Processes

*by;*

*Colin Hume*
*George Wilhere [1]*
*Stephen Stanley*
*Susan Grigsby*
*Kelly Slattery*

March 2015
Publication No. 15-06-009

Shorelands and Environmental Assistance Program
Washington State Department of Ecology
Olympia, Washington

[1] Habitat Program
Washington State Department of Fish and Wildlife
Olympia, Washington

# Table of Contents

Page

# List of Figures and Tables

## Figures

Page

# Tables

Page

# Acknowledgements

The authors of this report would like to thank the following people for their contribution to this study:

- Beth Ledoux, King County, Snohomish Basin Protection Plan Project Team
- Josh Kubo, Tulalip Tribes, Snohomish Basin Protection Plan Project Team
- Barb Carey, Washington State Department of Ecology
- Doug Peters, Washington State Department of Commerce

# Executive Summary

Watershed Characterization is a set of assessments of water and habitat condition that compares areas for their relative value. This coarse scale information gives a landscape view for regional and watershed-based planning. It provides information for decision makers to determine the most suitable areas for protection and restoration of resources, and the best use of limited funds.

This report was developed to support the efforts of the Snohomish Basin Salmon Recovery Forum in the development of an addition to their Salmon Conservation Plan for the Snohomish basin (Water Resources Inventory Area/WRIA 7). The addition focuses on strategies for protection of hydrologic processes that support fish habitat. Thus, the approach described here has the following purposes:

> *1) identify priority areas to protect hydrologic processes that support salmonid habitat, and*
>
> *2) identify strategies to protect those hydrologic processes.*

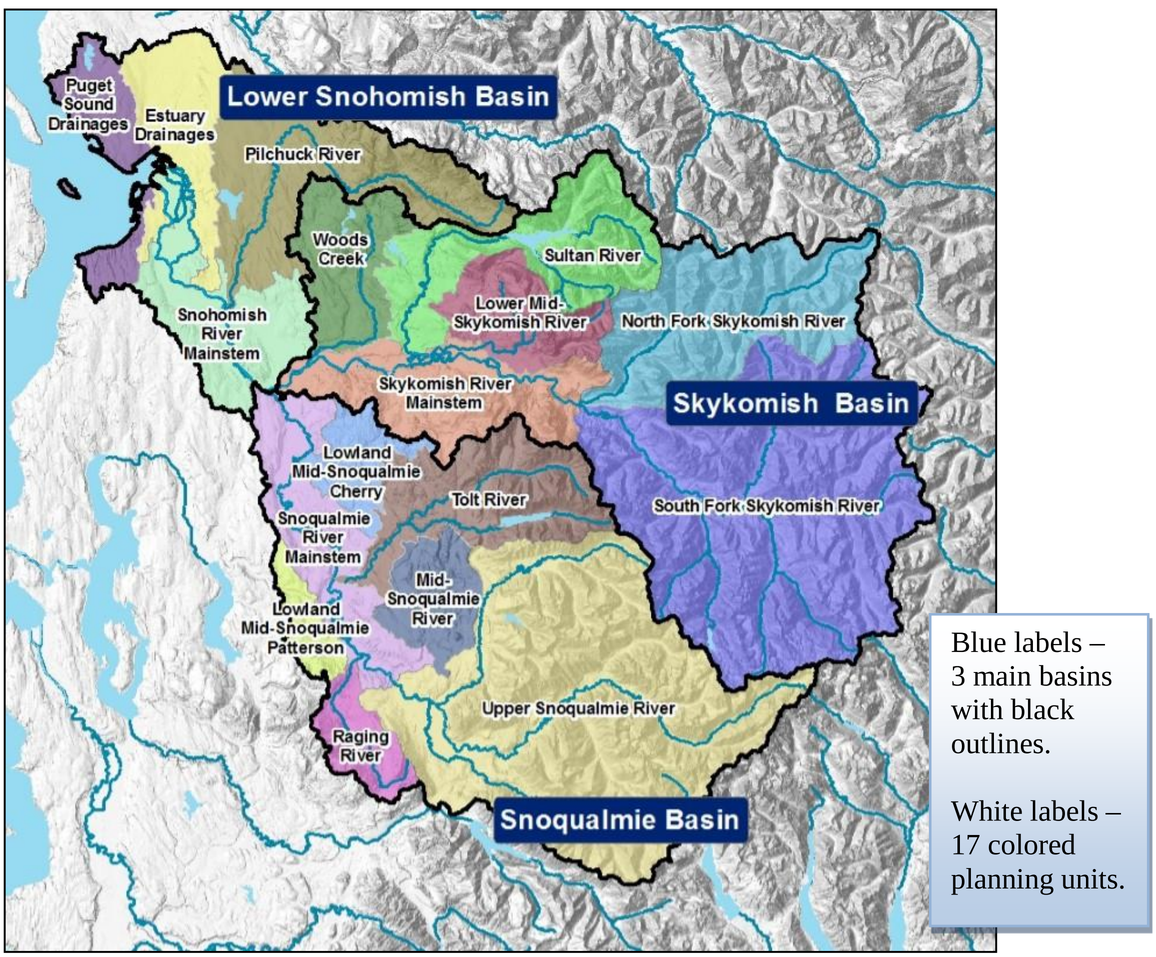



**Figure I. The Water Resource Inventory Area 7, the Snohomish Basin.**

This document outlines a technical approach using the Puget Sound Watershed Characterization (PSWC) assessments of water flow processes, sediment process degradation, and local salmonid habitat value for watersheds within WRIA 7 (Figure I). The summaries presented here are intended to assist King and Snohomish Counties in developing planning level strategies to help identify and locate land protection measures that provide the greatest relative benefit to water flow processes and salmonid habitat. These measures can be further developed into land use policies and development standards.

**Using the Watershed Characterization Assessment**

The PSWC is a set of water flow and habitat assessments that compare areas for their relative value and relative level of degradation. They are coarse-scale indices intended to provide information for local, county, and regional watershed-based planning. The assessment results in this document address the following primary questions for WRIA 7:

(1) ***Where on the landscape*** should protection efforts be focused first to benefit water flow processes and salmonid habitats in the WRIA 7 watershed?

(2) ***What types of activities and actions*** at a watershed scale are most appropriate based on the assessment results?

The assessment results therefore address both “where” and “what” to focus on, in terms of water flow and salmonid habitat. Further, this approach integrates results from the assessment of sediment processes to identify where salmon habitat may need additional protection actions.

**Water Flow Assessments**

The water flow assessment uses two models, the *importance of water flow processes* and the *degradation of water flow processes*. Each model provides a ranking from low to high for how important or how degraded each *assessment unit* (AU) is relative to the other units in the watershed. These two ranks are then plotted on the Management Matrix to determine the general management category (Figure II), and identify those areas that are more suitable for protection or restoration actions. See Stanley et al. 2011 for a complete description of these methods.

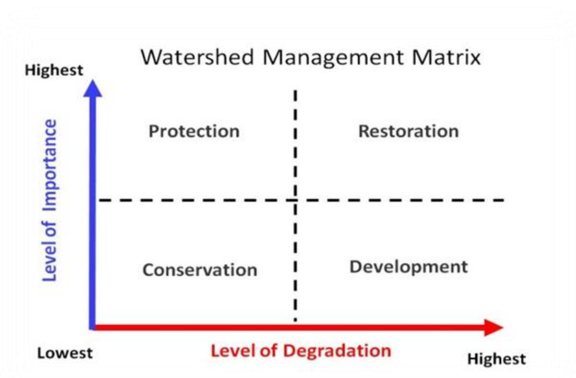



**Figure II. The Management Matrix for water flow which categorizes assessment unit results for both importance and degradation models.**

The importance model evaluates the watershed in its historic “unaltered” state. This provides a comparison of the intrinsic potential of an area relative to other areas. The model combines delivery, surface storage, recharge, and discharge components to compare the relative value of AUs for maintaining overall water flow processes in a non-degraded setting. This model highlights areas with landscape features that naturally support water flow processes and may be more responsive to restoration efforts.

The water flow degradation model rates each watershed in its altered state to consider the impact of human actions on water flow processes. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative value of AUs to the degradation of overall water flow processes. Degradation of these processes generally accelerates the movement of surface flows downstream. This accelerated delivery increases downstream flooding and erosion and eventually degrades aquatic habitat (Stanley et al. 2011). This model highlights areas on the landscape that may need more active management for improvement.

**Sediment Assessment**

The water quality assessment for sediment degradation evaluates the watershed in its “altered” state by use of a numerical model, N-SPECT (the “Nonpoint-Source Pollution and Erosion Comparison Tool”). This model assesses the degree of existing degradation to sediment processes based on GIS land-use data. The sediment degradation submodel uses a compilation of “typical” contaminant loadings (event mean concentration) for various land uses.

**Habitat Assessment**

The *watershed habitat index* (WHI) evaluates a watershed for its relative quality and quantity of stream miles important to salmonids, and is alternately referred to as the *local salmonid habitat*. The SBPP Project Team chose to integrate this component of the freshwater habitat assessment with the water flow and sediment process degradation assessments.

**Combining Assessments for Recommendations**

The process for determing land use recommendations and priorities for the water flow process is a qualitative exercise. This approach uses the assessment results and Management Matrix (Figure II) as a diagnostic tool. The Matrix helps evaluate the water flow assessment for both relative importance and degradation across a watershed or basin which contains multiple AUs. The intent of these recommendations is to tell the “story” of a watershed. The story can guide land use decisions and help prioritize protection of different features and controls on the important water flow processes in a given set of AUs.

The Snohomish Basin Protection Plan (SBPP) Project Team decided to identify priority areas for protection based upon highest relative importance to water flow processes. Therefore the level of degradation was used secondarily to group the priority AUs into a protection or restoration category ( illustrated in Table I below). In this way, degradation accounts for the strategies applied to equally important areas. Similarly, the overlay of local salmonid habitat assessment and sediment process degradation results can inform when strategies may add benefits for salmonids and when degraded sediment processes could undermine benefits.

**Scales of Assessment**

In this report we compare results for each analysis at multiple scales to inform different types of decisions (Figure III). All analyses produce a value for the smallest unit, the *assessment unit* (AU). We divided the WRIA into 268 assessment units, with an average size of 7 square miles.

These AUs can be grouped by the three large basins of the WRIA, or by the smaller *planning units* within those basins. To tell a complete story with the results, the AUs are compared at several scales.

First, AU results are summarized at the WRIA level or Scale 1. This compares the average value of the assessment units within each of the three basins (heavy black boundaries) of WRIA 7 to each other.

Next, assessment results are summarized at the basin level, or Scale 2, which compares the average value of the smaller planning units (17 colored units) within that basin.

Finally, the planning unit level, or Scale 3, identifies individual assessment units that have a higher priority for protection or restoration. The combination of results for all three assessments at all three scales provides different options for management considerations.

Figure IV shows the nested scales and describes how the assessments apply at each.

**Watershed Scales**

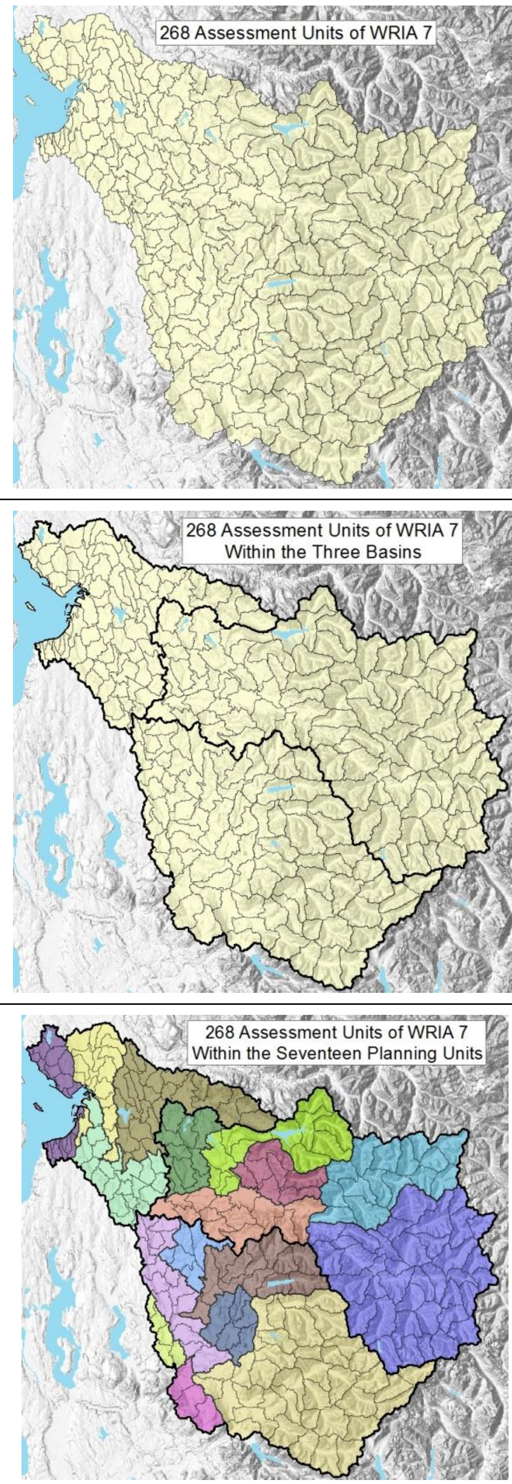



**Figure III. The three scales of assessment.**

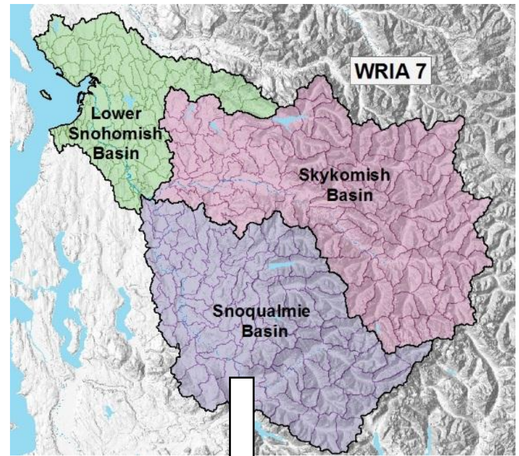
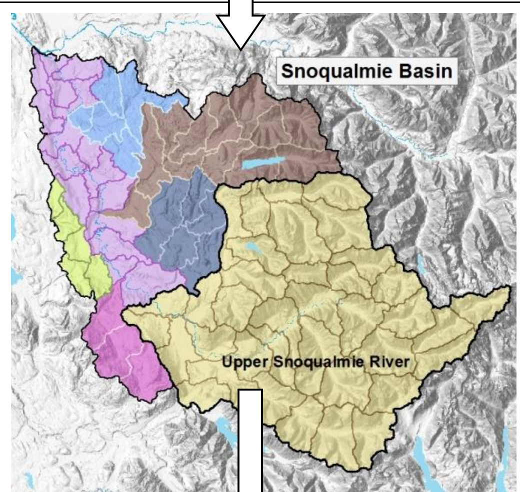
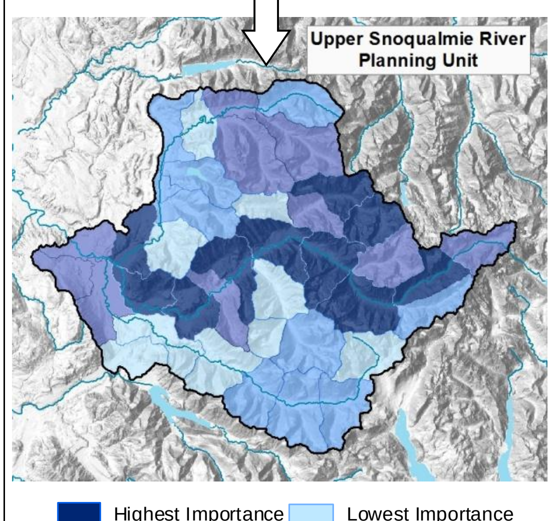
| Assessment scales and uses in the report | Watershed Scales |
|---|---|
| **Scale 1 – WRIA Level – Compares Basins**<br>- Water flow assessment results compare the average rank for the three basins to each other, and then the average rank of the planning units to each other.<br><br>- Sediment process degradation results compare basins by average rank.<br><br>- Local salmonid habitat results compare planning units by area weighted mean. |  |
| **Scale 2 – Basin Level – Compares Planning Units**<br>- Water flow assessment results identify overall land use recommendations and priority subcomponents of the water flow process to prioritize for protection and restoration measures.<br><br>- Sediment process degradation results compare planning units by average rank.<br><br>- Local salmonid habitat results compare planning units by area weighted mean. |  |
| **Scale 3 – Planning Unit Level – Compares AUs**<br>- Water flow results identify the highest priority assessment units for overall importance to water flow processes<br><br>- Sediment process degradation results identify assessment units which may be degraded to a point where protection efforts could be undermined.<br><br>- Local salmonid habitat results identify which assessment units, if protection measures are implemented, may have higher benefit for salmonid habitat. |  |

**Figure IV. Application of the three scales of assessment.**

**Example - the North Fork Skykomish planning unit**

The following is an illustration of how an analysis summary can provide planning level guidance for protection strategies. At Scale 1, across the three primary basins of WRIA 7, the Skykomish *basin* generally ranks highest for overall importance to water flow processes and lowest for degradation to those processes. At Scale 2, within the Skykomish basin, the North Fork Skykomish *planning unit*, ranks highest for overall importance and is also ranked lowest for overall degradation to water flow processes. This would place the overall land use recommendation for this planning unit in the *Highest Protection* category based on the Watershed Management Matrix (Figure V, top left green box).

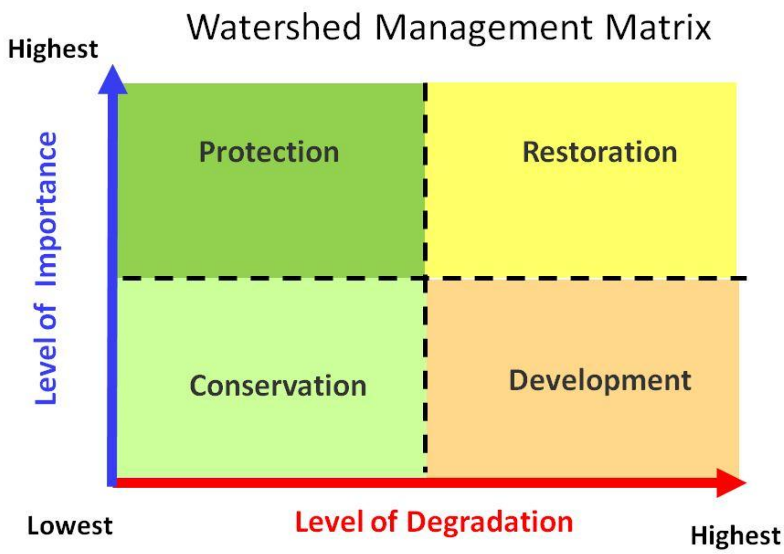



**Figure V. Watershed Management Matrix.**

At Scale 3 (Figure VI), four of the *assessment units* (AUs) rank in the highest category for protection of overall water flow processes. They represent the top row of the Management Matrix, and are indicated as the darkest green (#7008) and darkest yellow assessment units (#7108, 7010, & 7035). The results of the degradation to water flow, then determines each of these AU's to be in either the protection or restoration category. One of these (7008) ranks low for degradation to water flow, so it is under the *Protection Group* in Table I. The other three rank high for degradation to water flow, so they are under the *Restoration Group* (7108, 7010, 7035).

The local salmonid habitat results (mean WHI) rank the planning unit (scale 2) relatively low (5$^{th}$ out of 6) within the basin. However, at scale 3, a couple of AUs rank moderate, and one is highly ranked (#7010). This AU meets the threshold for importance to salmonid habitat (***** in Figure VI).

Sediment process degradation is relatively low for the planning unit (scale 2), however, the highest value AU for salmonid habitat (#7010) co-occurs with highly degraded sediment processes (scale 3) due to forestry activities on steeper slopes. Thus, any restoration efforts in this AU should consider the possible negative affects of sediment degradation on salmon habitat.

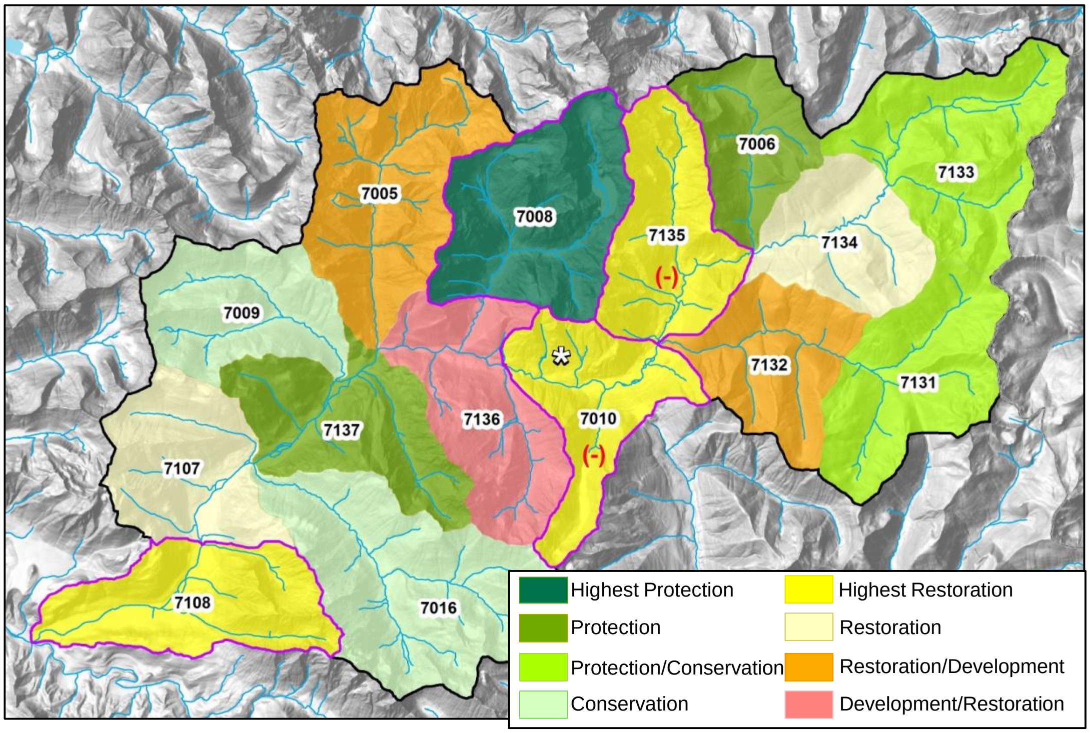



**Figure VI. Scale 3 priority assessment units (AUs) for water flow processes in the North Fork Skykomish planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. An asterisk (*) indicates the AU meets the cutoff threshold for local salmonid habitats. A minus (-) indicates the AU meets cutoff threshold for sediment process degradation.

**Table I. Priority assessment units for water flow in the North Fork Skykomish planning unit. Figure VI is an illustration of the results presented in this table.**

| ***Where?*** | |
|---|---|
| **Protection Group (AU id)** | **Restoration Group (AU id)** |
| 7008 | (-)7010*, 7108, (-)7135 |
| ***What?*** **Management considerations** | |
| Highest priority AUs which have lower relative degradation in the planning unit. | Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) indicates high potential for degraded sediment processes which could undermine protection of salmonid habitats.*Indicates high relative salmonid habitat value in AU. |

# Acronyms

ADH – Accumulative Downstream Habitats

AU - Assessment Unit

CEI – Composit Ecological Integrity

IP – Intrinsic Potential

N-SPECT - Nonpoint-Source Pollution and Erosion Comparison Tool

PSWC – Puget Sound Watershed Characterization

PU - Planning Unit

RHI – Reach Habitat Index

SBPP – Snohomish Basin Protection Plan

WHI – Watershed Habitat Index (or Local Salmonid Habitat Index)

WRIA – Water Resources Inventory Area

# Introduction

This report was developed to support the efforts of the Snohomish Basin Salmon Recovery Forum in the development of an addition to their Salmon Conservation Plan for the Snohomish basin (Water Resource Inventory Area/WRIA 7). The addition focuses on strategies for the protection of hydrologic processes that support fish habitat. Thus, the Snohomish Basin Protection Plan (SBPP) Project Team is developing a technical approach with the following purposes:

> *1) identify priority areas to protect hydrologic processes that support salmonid habitat in the watershed and*
>
> *2) identify strategies to protect the hydrologic processes that support the salmonid habitat.*

This document provides a summary of the Puget Sound Watershed Characterization (PSWC) assessments of water flow processes, degradation to sediment processes, and salmonid habitat for watersheds within WRIA 7 (Figure 1). These watersheds drain northward through the Snoqualmie and Skykomish Rivers, to their confluence forming the Snohomish River which ultimately flows through the Snohomish Estuary and into Puget Sound at the City of Everett.

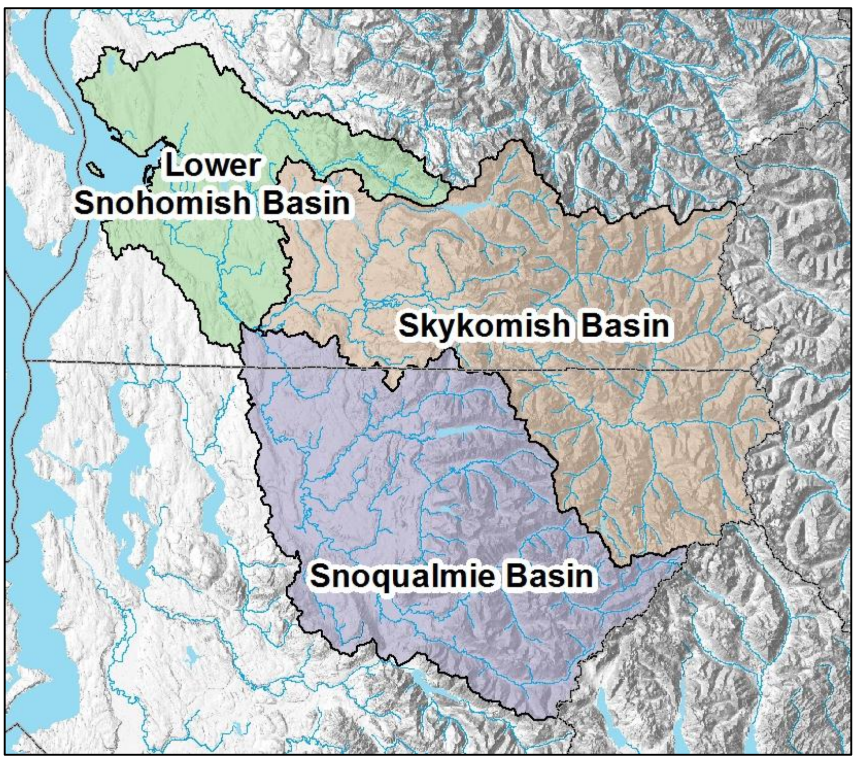



**Figure 1. WRIA 7 and its three major basins.**

The approach described in this report compares results for each assessment at multiple scales to inform different decisions. All assessment results are summarized first at scale 1, comparing the three basins within the WRIA and then subsequently at scale 2, comparing the 17 planning units (Figure 2) within the basins, and finally at scale 3, comparing the assessment units (AUs) within a planning unit (Figure 3). The order for presenting the results in this report will be to discuss the WRIA, then the individual basins (Lower Snohomish, Snoqualmie, and Skykomish) and then each of the planning units within the basin. The assessment uses methods developed by the Puget Sound Watershed Characterization Project (Stanley et al. 2011, Wilhere et al. 2013) which can be accessed at:

http://www.ecy.wa.gov/services/gis/data/inlandwaters/pugetsound/characterization.htm

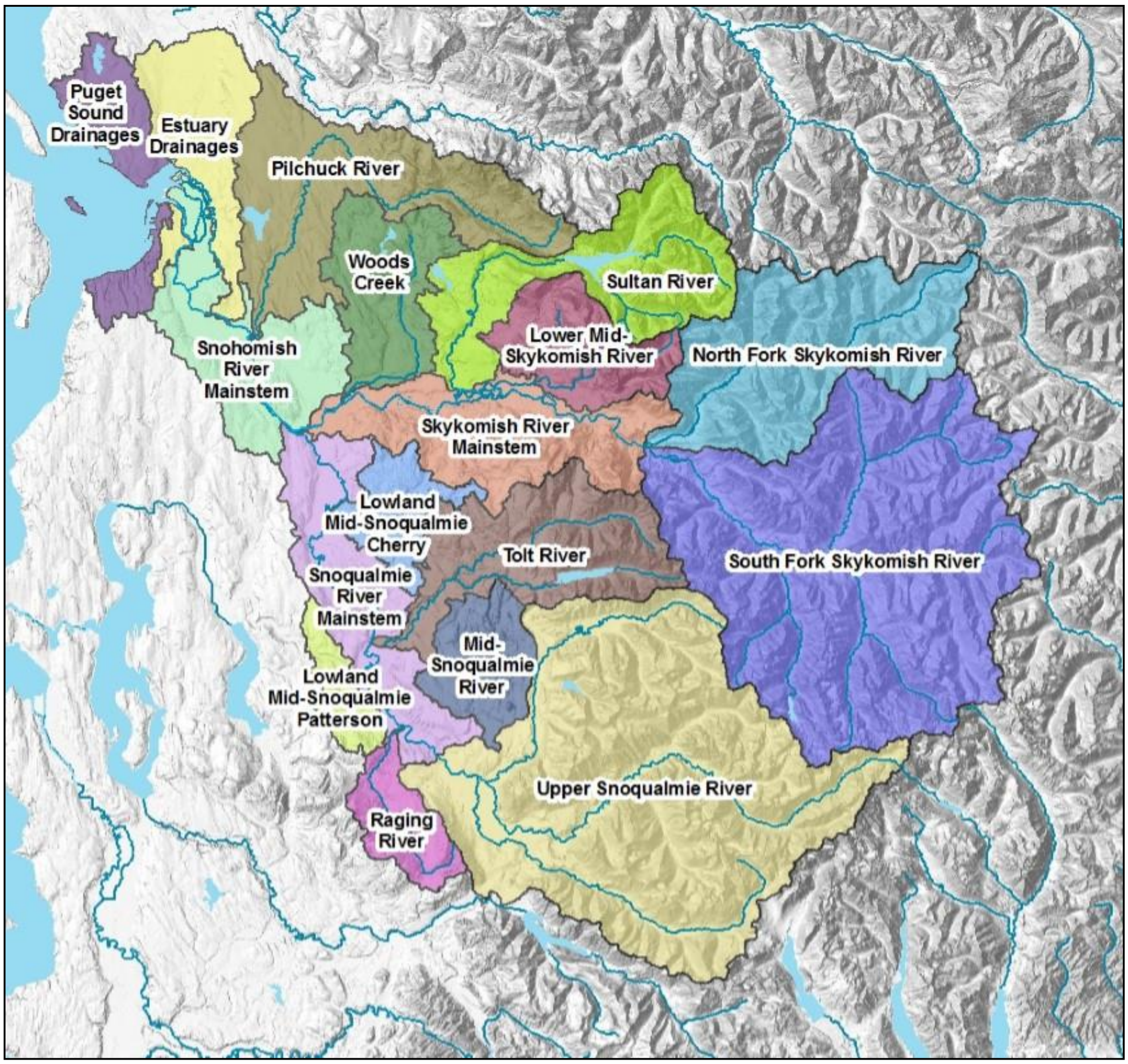



**Figure 2. Planning units within WRIA 7.**

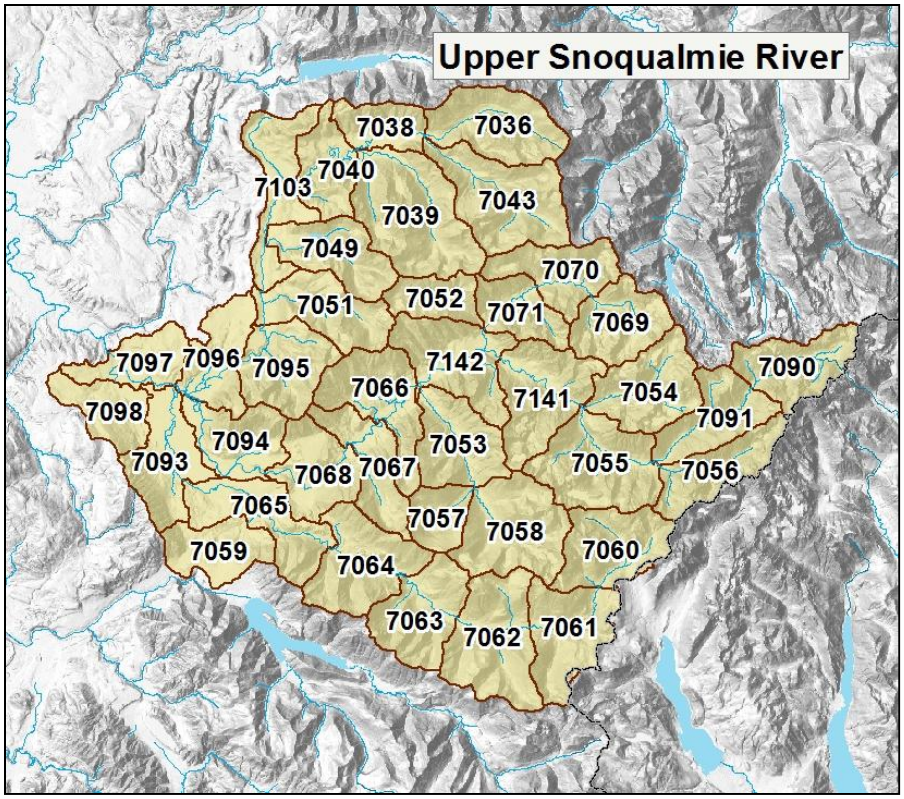



**Figure 3. Example of assessment units within a planning unit**. Numbers indicate assessment unit ID.

The results of the watershed characterization assessment presented here are intended to assist the land use planning jurisdictions within WRIA 7. These include King and Snohomish Counties, the cities, as well as non governmental organizations (NGOs) developing planning strategies that locate protection measures that provide the greatest relative benefit to water flow processes and salmonid habitat. These strategies can also support the development of land use policies and development standards.

# Background

The PSWC is a set of watershed process and habitat assessments that compare areas for their relative value and level of degradation. It is a coarse-scale decision-support tool that provides information for regional, county, and watershed-based planning. The information it provides allows local and regional governments, as well as non-governmental organizations (NGOs), to base their decisions regarding land use on a systematic assessment framework that prioritizes specific geographic areas on the landscape for protection, restoration, and conservation of our region's natural resources. Application of this method should result in future land-use patterns that contribute to protecting the health of Puget Sound's terrestrial and aquatic resources while also helping to direct limited financial resources to the highest priority areas for restoration and protection.

## What Questions Does This Document Address?

The assessment results in this document address the following primary questions for WRIA 7:

(1) *Where on the landscape* should protection efforts be focused first to benefit water flow processes and salmonid habitats in the WRIA 7 watershed?

(2) *What types of activities and actions* at a watershed scale are most appropriate based on the assessment results?

The assessment results therefore address both "where" and "what" to focus on, in terms of water flow and salmonid habitat. Additionally, this approach integrates results from the sediment process assessment to identify where protection actions may need to consider strategies to account for degraded sediment processes which could affect salmonid habitat.

The assessments are presented first for WRIA 7, then for the Lower Snohomish, Snoqualmie and Skykomish basins, and then for the 13 planning units defined by the SBPP Project Team for the Snohomish watershed. The results of each assessment at both the basin and planning unit scale are presented in tables that integrate the results across assessment types and provide an overall summary and recommended planning actions. These results nest within one another, with the basin results providing potential planning strategies and the planning unit analysis providing additional detail on location for protection and restoration actions at the assessment unit (AU) scale. The majority of the AU boundaries are the same for the WRIA, basin and planning unit analysis. However, for several of the planning units (e.g. Raging River), smaller size assessment units were created given that the original assessment units were not of adequate number to conduct a meaningful comparison of results.

**Limitations**

Care should be taken to use the PSWC as intended. It is a coarse-scale assessment and is not intended for site-specific application; finer scale data, local information and technical expertise will be needed for those decisions. In addition:

- The PSWC is for planning purposes only. This does not affect or alter existing land use or environmental regulations, although it may be used to help inform future land use and regulatory decisions.

- For this assessment, scores were normalized across all AUs at each scale, which allows direct comparisons of results across basins and planning units. Therefore, these results should not be compared to the maps available on the Washington State Department of Ecology PSWC website, which uses an additional unit/filter called "landscape group" (Stanley et al. 2011, pg. 43).

- Results and recommendations at a watershed scale (i.e. WRIA, planning unit, AU) represent land-use planning-level information. At the project-scale, each watershed will represent a combination of on-the-ground challenges and opportunities. A watershed rated as a low priority for restoration does not mean there are no suitable restoration sites or opportunities. Similarly, not every site in an watershed that is a high priority for restoration will be suitable for restoration.

- The assessments are landscape-scale and consequently do not address site-specific issues that are best addressed through finer-scale studies. Finer-scale or site-level actions will remain essential to the success of local restoration efforts. When developing site-level plans, jurisdictions will have to evaluate the need for finer-scale information and collect it where needed.

- The PSWC assessments and indices utilize readily available geospatial data which is consistent in resolution and covers the extent of Puget Sound. As such, there are “local” data layers which could improve the confidence in the calculations, but were out of the scope of this project to acquire.

# Fundamental Concepts of Watershed Characterization

The following section on water flow and sediment processes summarizes concepts and methods outlined in detail in Stanley et al. 2011 and associated appendices.

Watershed processes are defined as the dynamic physical and chemical interactions that form and maintain the landscape and ecosystems on a geographic scale of watershed to basins. This includes the movement of water, sediment, nutrients, pathogens, chemicals and wood. As described in Stanley et. al. 2011, the PSWC is built on the basic relationships between ecosystem processes, structure, and function. Ecosystems are influenced by the broad physical and chemical fluxes (the driving processes) of water, nutrients, sediment, and organic material. These processes interact to help form structural attributes such as pools and log jams in streams which in turn support habitat function.

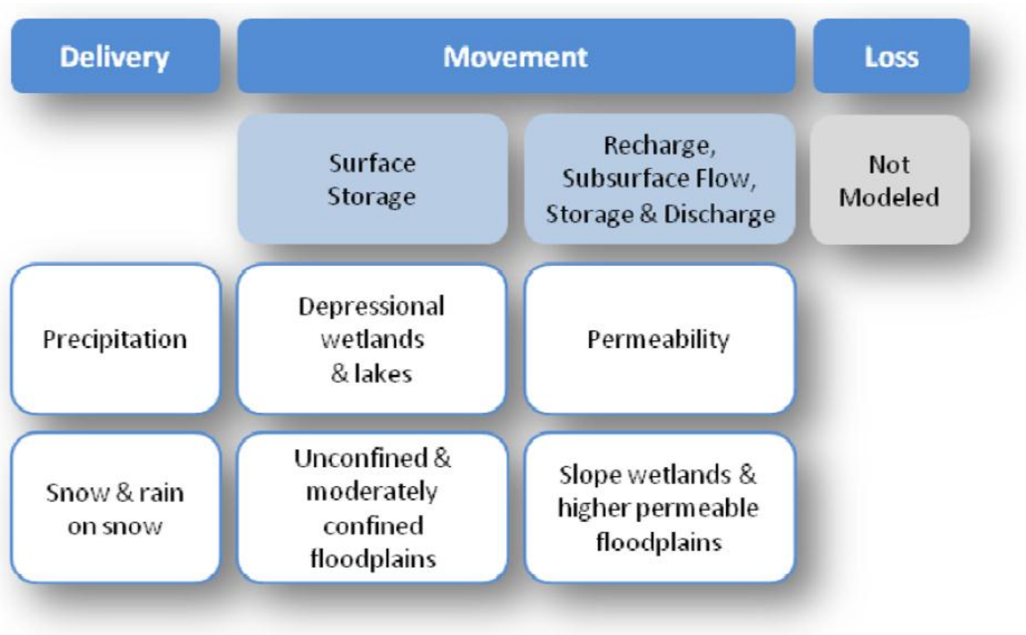
Watershed process are controlled and influenced by natural attributes and human actions. Natural controls on watershed processes include physical attributes of the ecosystem such as geomorphology, geology, and soils. Many human actions influence watershed processes. For example, timber harvest may reduce the amount of wood entering streams. Shoreline armoring can reduce sediment input from bluffs and alter the erosion, movement, and deposition of sediments along beaches. Urban development can increase the amount and amplitude of stormwater runoff.  PSWC attempts to model these watershed processes such that areas of the landscape can be identified which are relatively more important (presence of natural controls) or more degraded due to human impacts.

## The Water Flow Assessment

The water flow assessment uses two models to compare the *importance* and *degradation* of water flow processes in a watershed to identify areas that are relatively more suitable for protection or restoration of these processes.  Each model provides a ranking from low to high for how important and how degraded each assessment unit is relative to the other units in the watershed. The water flow models, and all other PSWC assessments utilize readily available geospatial data for its calculations, which is consistent in resolution and covers the extent of Puget Sound to allow for comparisons of relative value. As such, there is often other data, specific to a local area, basin or planning area which was not utilized but could improve the confidence in comparisons. This was out of the scope of this project.

The importance model (Figure 4) evaluates the watershed in its historic “unaltered” state. The reason for this is to compare what areas of a watershed have greater intrinsic potential to support water flow processes. It is not intended to provide a goal for restoration outcomes.

The importance model combines the delivery, surface storage, recharge, and discharge components to compare the relative value of analysis units for maintaining overall water flow processes in a non-degraded setting. When precipitation is “delivered” as either rain or snow, there are physical features that control the surface and subsurface movement of that precipitation within an assessment unit. These physical features include land cover, storage areas such as wetlands and floodplains, areas of higher infiltration and recharge, and areas that discharge groundwater. These areas are considered “important” to the overall water flow process.




.

**Figure 4. Importance model for overall water flow processes.**

In the water flow process degradation model (Figure 5) the watershed is evaluated in its “altered” state to consider the impact of human actions on water flow processes. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative degradation to overall water flow processes of the AUs. Degradation to these processes generally accelerates the movement of surface flows downstream. This accelerated delivery increases downstream flooding and erosion and eventually degrades aquatic habitat over time (Stanley et al. 2011).

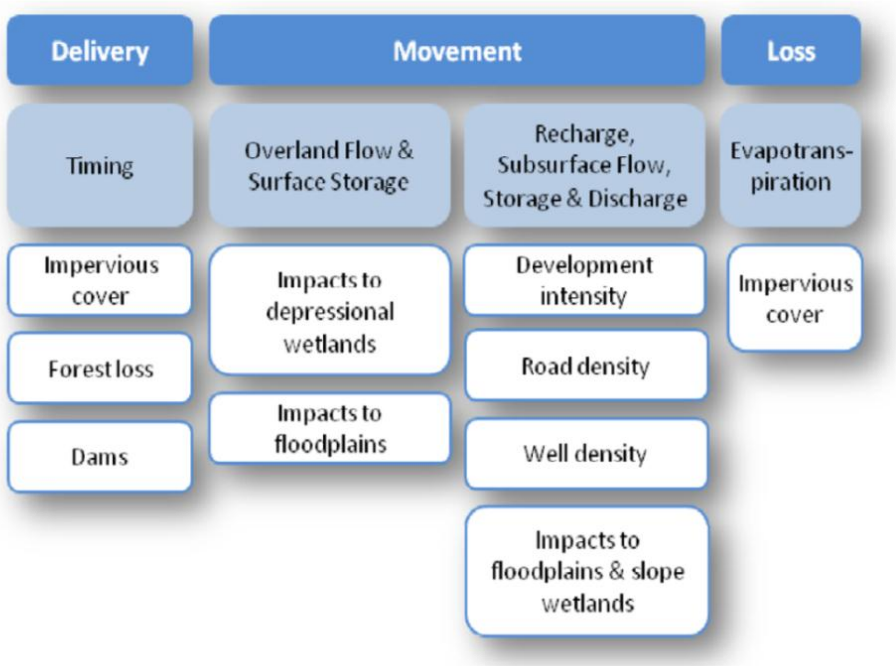



**Figure 5. Degradation model for overall water flow processes.**

Combining the results of the importance and degradation models yields a simple matrix that planners can use, along with other science-based information, to inform land management strategies and actions. The combined matrix (i.e. Management Matrix depicted in Figure 6) can be looked at for each model component (delivery, surface storage, recharge, discharge) and as a combined result of all the model components (overall water flow). While each color on the matrix contains a management priority (e.g. protection, restoration, development) these labels or categories are most appropriately applied to certain scenarios such as Growth Management Act updates, and can be adapted to meet local needs in conveying the information. At its simplest, this Management Matrix conveys which areas are relatively:

*High importance – low degradation = protect*
*High importance – high degradation = restore*
*Low importance – low degradation = conserve*
*Low importance – high degradation = develop*

The PSWC project generally prioritizes protection actions in watersheds which are highly important and are relatively less degraded for watershed processes when resources to enhance or restore these areas are limited. This does not mean that there are not important areas or necessary restoration actions in assessment units that are not highly important and highly degraded. Rather, given limited resources these might be the first place a planner would want to focus on to increase the likelihood of improving watershed processes in key areas.

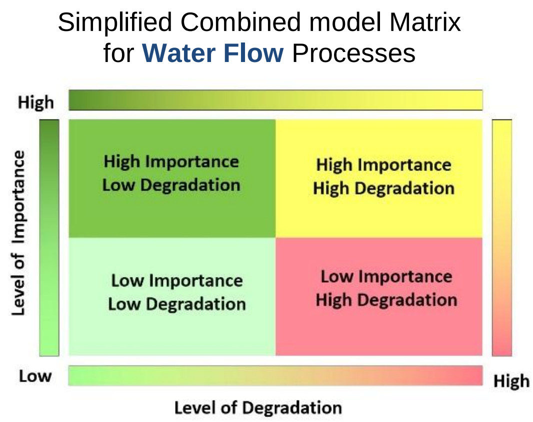
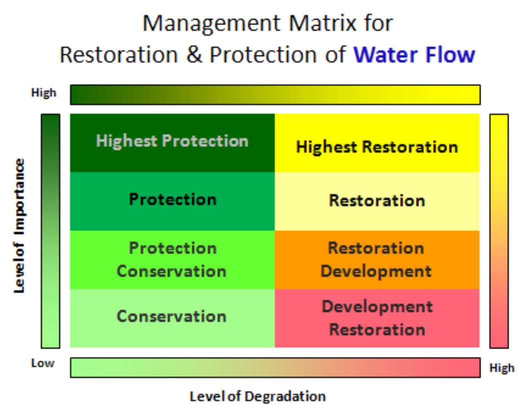
| | |
|---|---|
| **Combination of importance and degradation models for water flow processes**<br><br>Assessment units are binned according to both their relative level of importance and degradation. For example, those assessment units which score moderate-high to high for both importance and degradation will fall somewhere in the yellow quadrant. |  |
| **Management Matrix for water flow indicating relative priorities for restoration and protection of processes**<br><br>By accounting for both the relative level of importance and the relative level of degradation of an assessment unit, one can begin to prioritize which areas of a watershed to apply management strategies which protect (highest importance, lowest *degradation*) water flow processes, and which areas to prioritize restoration (highest importance, highest *degradation*) or enhancement strategies. |  |





**Figure 6. Management Matrix of restoration and protection priorities for water flow processes** which combines the results of the two models for importance and degradation to categorize each assessment unit.

## Management Recommendations for Water Flow

The integration tables presented in the basin and planning unit analyses will refer to management recommendations for specific submodels (i.e. delivery, storage, recharge, discharge) of the water flow process. These recommendations are based on Volume 1 of the PSWC (Stanley et. al. 2011) and its technical appendices for water flow and water quality assessments. The results for water flow processes are summarized with statements that propose, based upon an evaluation of both the level of importance and degradation of a group of or individual AU, processes which could be prioritized for restoration, protection, or conservation. The following recommendations, summarized in Tables 1-4, are organized around land use type and submodel of the water flow process. They can be used to determine broad actions at a watershed scale which could provide protection or restoration of specific subcomponents of water flow process.

These recommendations are based on existing peer reviewed research (summarized in Stanley et al. 2011 and associated appendices) that has observed and documented the environmental features that regulate or control the flow of water and sediment and how their degradation affects these processes. If these features are changed by land use activities then the model provides a relative assessment of degradation to the process. The models use these indicators of water flow and water quality processes and so do not represent direct measurements of rates of flow (e.g. peak flows, their frequency and duration) or water quality pollutants (e.g. loading or concentration of pollutants). If available, the previously mentioned finer scale information can be used in conjunction with the coarser scale information such as PSWC assessments to determine actual cause and effect and help develop detailed actions for actual restoration plans. These are not, however, part of the recommendations in this document.

**Forest Lands –Mountainous Setting**

Water delivery is a key process in forest lands, due to higher precipitation and presence of rain-on-snow and snow dominated zones. Delivery plays a key role in regulating and maintaining the normal range of downstream flows. This in turns helps maintain stream structure and function. The controls for delivery include forest cover and rain-on-snow and snow dominated areas, all of which regulate the timing of flows downstream. Because areas important for regulating the delivery of water will have a greater influence downstream when located in the upper watershed, it should be a high priority to protect these areas (intact forest) in the upper watershed. For most mountainous landscape settings that do not include national parks or wilderness, logging is the principal activity. The construction of logging roads and cutting of forest cover degrade delivery processes.

Areas important to storage are not as prevalent in higher elevation forest zones due to more constrained floodplains and steep topography that limits the extent of depressional wetlands. Lakes, however, can be important areas for storage of water.

Recharge and discharge are important processes in forested lands. Recharge from snowmelt, contributes to regional groundwater flow systems. Discharge areas, consisting of slope wetlands at the base of mountainous valleys, are key contributors to stream flow as is groundwater discharge directly within stream alluvial deposits. Logging, rural roads and associated ditches can capture shallow groundwater flow and alter the natural pattern of groundwater recharge and discharge (see Figure 7 for a visual example). Table 1 provides general management recommendations for forested lands in a mountainous setting

**Table 1. Management recommendations (from Stanley et al. 2011) for forest lands for each water flow management category.** Protection (P), Restoration (R), Conservation (C), and Development (D). Applicability of the recommendations to each submodel are also indicated (DE= delivery, SS=surface storage, RD=recharge and discharge). GW = groundwater.

| FOREST LANDS | P | R | C | D |
|---|---|---|---|---|
| Common issues: widespread loss of vegetative cover, particularly in high-elevation snow and rain-on-snow areas, high in watersheds and so affecting many reaches downstream. Creation of new impervious surfaces is rare, although a dense forest road network can greatly alter flow paths and sediment production. | | | | |
| Reduce number of stream crossings by roads (SS) | ☑ | ☑ | ☑ | ☑ |
| Reduce interception of shallow GW in channels and road ditches (RD) | ☑ | ☑ | ☑ | ☑ |
| | | | | |
| Replant deforested areas (DE) | ☑ | ☑ | | |
| Ensure zoning is consistent with long-term protection of resources (e.g., large parcel size; stable urban growth boundary) (DE, SS, RD) | ☑ | ☑ | | |
| Decommission and remove unneeded forest roads (SS, RD) | ☑ | ☑ | | |
| Increase size of protected areas around streams/wetlands (DE, SS, RD) | ☑ | ☑ | | |


**Figure 7. An example of forest activities in a mountainous setting.** Clearing of forest (e.g. yellow circle) impacts delivery processes and roads (e.g. yellow arrow) impact discharge processes by intercepting shallow groundwater flow.

**Rural Lands and Agricultural Lands – Lowland Setting**
Rural lands include rural residential development and agricultural activities, both commercial and non-commercial operations. Rural lands are typically located outside of urban growth boundaries, in lowland zones and transition to the lower elevations of mountainous landscape settings.

Storage is a key process in rural lands due to broader "glacially formed" floodplain areas and terraces that create numerous areas for depressional topography. Rural land uses, especially commercial agriculture, have degraded storage processes by channelizing and disconnecting floodplains from rivers and streams and draining or filling depressional wetlands .

Recharge and discharge are also key processes in rural lands due to the presence of permeable outwash and alluvial deposits, particularly in glacial terraces and floodplains. Areas important to discharge processes are concentrated in large floodplain areas and slope wetlands adjacent to rivers and can play an important role in maintaining low flows and stream temperature. Table 2 below presents general management recommendations for water flow processes in rural lands.


**Figure 8. Visual example of impacts to discharge areas in lowland rural areas.**

**Table 2. Management recommendations for rural lands for each water flow management category** (from Stanley et al. 2011). Protection (P), Restoration (R), Conservation (C), and Development (D). Applicability of the recommendations to each sub model are also indicated (DE= delivery, SS=surface storage, RD=recharge and discharge). GW= groundwater

| RURAL LANDS | P | R | C | D |
|---|---|---|---|---|
| Common issues: Rural land use can drain key headwater wetlands, with potentially great effect on downstream flooding and erosion. Septic systems can be a source of nutrients and pathogens. Forest clearing increases overland flows, affecting stream/wetland structure and function. Groundwater withdrawal in rural residential areas can affect downstream discharge areas. For relevant literature see: http://www.ecy.wa.gov/biblio/wq.html | | | | |
| Require [properly functioning] septic systems (RD) | ☑ | ☑ | ☑ | ☑ |
| Emphasize dispersive/infiltrative stormwater management (DE) | ☑ | ☑ | ☑ | ☑ |
| | | | | |
| Ensure zoning is consistent with long-term protection of resources (e.g., clustered development, stable urban growth boundary) (DE, SS, RD) | ☑ | ☑ | | |
| Increase size of protected areas around streams/wetlands (DE, SS, RD) | ☑ | ☑ | | |
| Reduce drainage density of artificial channels (SS, RD) | ☑ | ☑ | | |
| Revegetate upland areas (DE, SS) | ☑ | ☑ | | |
| Reduce GW withdrawals (RD) | ☑ | ☑ | | |
| Reduce interception of shallow GW in channels and road ditches (RD) | ☑ | ☑ | | |
| Replant deforested areas (DE) | ☑ | ☑ | | |
| Set back dikes/levees in key areas to restore overbank flooding (SS) | | ☑ | | |
| Restore stream reaches, floodplains, or wetlands to recover lost processes and functions (SS, RD) | | ☑ | | |

Agricultural and urban activities, especially wells, reduce these groundwater discharges which in turn can reduce low flows and increase stream temperatures. Ditching and draining of floodplain wetlands, including roads and ditches, changes patterns of groundwater discharge (see Figure 8 for an example). Commonly, this routes discharging groundwater more rapidly downstream, altering historic patterns of discharge and stream temperature regimes. Restoration measures can include rehabilitation of key discharge areas and conservation programs to reduce groundwater pumping. Table 3 below presents general management recommendations for water flow processes in agricultural lands.

**Table 3. Management recommendations for agricultural lands (from Stanley et al. 2011). Protection (P), Restoration (R), Conservation (C), and Development (D). Applicability of the recommendations to each sub model are also indicated (DE= delivery, SS=surface storage, RD=recharge and discharge). GW = groundwater**

| AGRICULTURAL LANDS | P | R | C | D |
|---|---|---|---|---|
| Common issues: Extensive drainage system reduces residence time of water on landscape and increases downstream delivery of water, and also compromises water-quality functions of wetlands and floodplains. Potential source of nutrients, pathogens and sediment that impact downstream aquatic area; lack of vegetated buffers increases delivery and transport of materials into aquatic systems. Floodplains disconnected from overbank flooding and tidal processes. Groundwater withdrawals and diversions can significantly affect low-flow regimes and wetland hydrology. | | | | |
| Apply source controls for nitrogen and pathogens (SS) | ☑ | ☑ | ☑ | ☑ |
| Allow greater residence time of water on fields and ditches outside of growing season (SS, RD) | ☑ | ☑ | ☑ | ☑ |
| Encourage [properly functioning] septic systems (RD) | ☑ | ☑ | ☑ | ☑ |
| | | | | |
| Ensure zoning is consistent with long-term protection of agriculture and resources (e.g., large parcel size; stable urban growth boundary) (DE, SS, RD) | ☑ | ☑ | | |
| Reduce GW withdrawals (RD) | ☑ | ☑ | | |
| Reduce drainage density of artificial channels (SS, RD) | ☑ | ☑ | | |
| Establish buffers for water-quality improvement in strategic areas (DE, RD) | ☑ | ☑ | | |
| Reduce interception of shallow GW in channels and road ditches (RD) | ☑ | ☑ | | |
| Revegetate upland areas (DE, SS) | ☑ | ☑ | | |
| Set back dikes/levees in key areas to restore overbank flooding (SS) | | ☑ | | |
| Restore degraded stream reaches, floodplains, or wetlands to recover lost processes and functions (SS, RD) | | ☑ | | |
| Restore highly infiltrative soils (RD) | | ☑ | | |

## Urban Lands – Lowland and Mountainous Valley Setting

Urban areas in Puget Sound are commonly located on lowland glacial terraces (e.g. City of Everett) or within broad glacial valleys (e.g. Monroe), with smaller urban areas located at the base of mountainous watersheds (e.g. North Bend). These urban areas have the highest level of process degradation relative to the other land uses. Clearing of forest, filling/draining of wetlands and installation of impervious surfaces significantly alters runoff processes resulting in higher peak flows to streams and rivers. As a result, stream and river structure can be simplified, which in turn reduces species richness. Impervious surfaces also impede recharge which along with groundwater pumping can reduce groundwater discharge to streams and wetlands (Table 4).

**Table 4. Management recommendations for urban and suburban lands** (from Stanley et al. 2011). Protection (P), Restoration (R), Conservation (C), and Development (D). Applicability of the recommendations to each sub model are also indicated (DE= delivery, SS=surface storage, RD=recharge and discharge). GW = groundwater

| URBAN & SUBURBAN | P | R | C | D |
|---|---|---|---|---|
| Common issues: Areas of impervious surface impair multiple water-flow processes, resulting in simplification of habitat structure and functions, and compromising effective restoration of structure and function of aquatic habitat. Significant transport of pollutants generated by urban uses to aquatic areas. Note that development regulations will preempt/supersede some of these recommendations. | | | | |
| Emphasize dispersive/infiltrative stormwater management (DE, SS, RD) | ☑ | ☑ | ☑ | ☑ |
| | | | | |
| Increase widths of protected wetland, stream, and marine riparian zones (DE) | ☑ | ☑ | | |
| Reduce GW withdrawals (RD) | ☑ | ☑ | | |
| Reduce interception of shallow GW in channels and road ditches (RD) | ☑ | ☑ | | |
| Revegetate upland areas (DE, SS) | ☑ | ☑ | | |
| Retrofit structures and roads for greater infiltration (DE, RD) | | ☑ | | |
| Construct stream reaches or artificial wetlands to recover lost processes and functions if/as feasible (SS, RD) | | ☑ | | |

## Assessment of Sediment Processes

Within the overall approach of the PSWC assessments, water quality is a key element to inform management decisions. For this project we have selected the sediment assessment model, given that the erosion, movement and loss of sediment plays a key role in the formation of aquatic structure and functions. The sediment model parallels the structure of the water flow model, having two distinct submodels: one for "export potential" (analogous to the "importance" submodel for water flow) and one for "degradation." We decided that the degradation model provided the most useful information for the purposes of this project and is therefore included in each of the basin and planning unit result tables.

The water quality degradation model evaluates the watershed in its "altered" state by use of a numerical model, N-SPECT (the "Nonpoint-Source Pollution and Erosion Comparison Tool"). This model assesses the degree of existing degradation to sediment processes based on GIS land-use data. The sediment degradation submodel uses a compilation of "typical" contaminant loadings (event mean concentration) for various land uses. These coefficients quantify the relationship between land use/land cover and pollutant amounts, and it is applied to the land cover grid across the entire Puget Sound basin. Though the raw results are on a pixel-by-pixel (i.e., 30×30 meter) basis, in the Characterization framework these results are summed and averaged by AU. They are then ranked from highest value (1) to lowest value (268) across the entire WRIA. These ranked results can then be aggregated by planning unit or basin for further comparison.

## Methods of the Freshwater Habitats Assessment

For a detailed explanation of the freshwater habitats assessment refer to Wilhere at al. (2013).

**Conceptual Foundation**

Our task was to assess the relative value of places for the conservation of fish habitats. Our approach for assessing relative value was the calculation of indices. An index reduces a complex, multi-dimensional system down to a single number. The resulting simplification facilitates planning and policy making. Our indices provide a big-picture view of relative conservation value over the landscape within an entire county or water resource inventory area (WRIA). Summary indices such as ours cannot be used to understand the status of particular species or habitats or to design site-level projects. Our indices may even mask some important aspects of conservation value, but when interpreted properly, the indices can facilitate better decisions regarding landscape-level habitat protection and land use (Failing and Gregory 2003).

The principal challenge we faced in developing the index were the limitations imposed by the currently available spatial data. Occurrence data for native freshwater animal species collected by WDFW and other agencies focus almost entirely on harvested species, and consequently, we have reasonably accurate data across the entire Puget Sound basin for only salmonid species. The shortcomings of the available spatial data led to an assumption that the eight salmonid species and their major life-history variants could effectively serve as umbrella species for all other species that rely on lotic, or freshwater stream habitat types. Consequently, salmonid species richness[1] and the amount and quality of salmonid habitats are major influences within the index.

**An Umbrella Species Approach**

The relative value of places for fish and wildlife conservation must in some way be related to the most basic requirement of every species – habitat. In freshwater lotic ecosystems of the Puget Sound basin the dominant vertebrate species are salmonids. We assumed that eight salmonid species and their major life-history variants – pink, chum, Chinook, coho, steelhead, rainbow trout, sockeye, kokanee, cutthroat, and bull trout[2] − could effectively serve as umbrella species for all other species that rely on lotic habitat types. An umbrella species is one whose conservation confers protection to numerous other co-occurring species (Fleishman et al. 2000). We believe this to be tenable for two reasons. First, collectively the eight species and their major life-history variants use a large proportion of every WRIA-sized[3] watershed. Those portions of a watershed where these species do not exist are very high gradient streams, headwaters, and areas above fish passage barriers. However, streams where salmonids do not exist are still important because they impact downstream salmonid habitats, and we accounted for this impact through

[1] Species richness means the number of species at a location.

[2] Sockeye and kokanee are life history variants of *Oncorhynchus nerka*. Steelhead and rainbow trout are life history variants of *Oncorhynchus mykiss*.

[3] WRIA is the acronym for water resource inventory area. The Puget Sound Basin consists of 19 WRIAs that range in size from 100,000 to 1.6 million acres. The mean size is about 460,000 acres.

an index that scores headwater streams based on the relative value of downstream salmonid habitats. Second, the egg, alevin, and juvenile life stages of salmonid species are sensitive to changes in water temperature, dissolved oxygen, and fine sediments. If these life stages are adversely affected by anthropogenic changes in a watershed, then other sensitive species may also be adversely affected. Therefore, places identified for protection or restoration of habitats for sensitive salmonid life stages will also result in the protection and restoration of habitats for non-salmonid species.

**Structure of the Freshwater Habitats Indices**

A comprehensive, detailed description of the freshwater habitats assessment is given in Wilhere et al. (2013). The WRIA 7 lead entity chose to use only the local salmonid habitat component as a habitat "lens" to integrate with water flow and sediment process assessments, however the entire Freshwater Habitat Index is briefely summarized below and is an option to include in future evaluations of the watershed to prioritize protection efforts.

The structure of the indices is organized as 5 tiers (Figure 9). The bottom tier has three components: hydrogeomorphic features, local salmonid habitats (the component used in the following assessment integration), and accumulative downstream habitats. Hydrogeomorphic features refer to the density of wetlands and undeveloped floodplains, which are landscape-scale features crucial to ecological processes that create and maintain lotic habitats. Local habitats are the salmonid habitats inside an AU, and accumulative downstream habitats are the salmonid habitats outside and downstream from an AU.

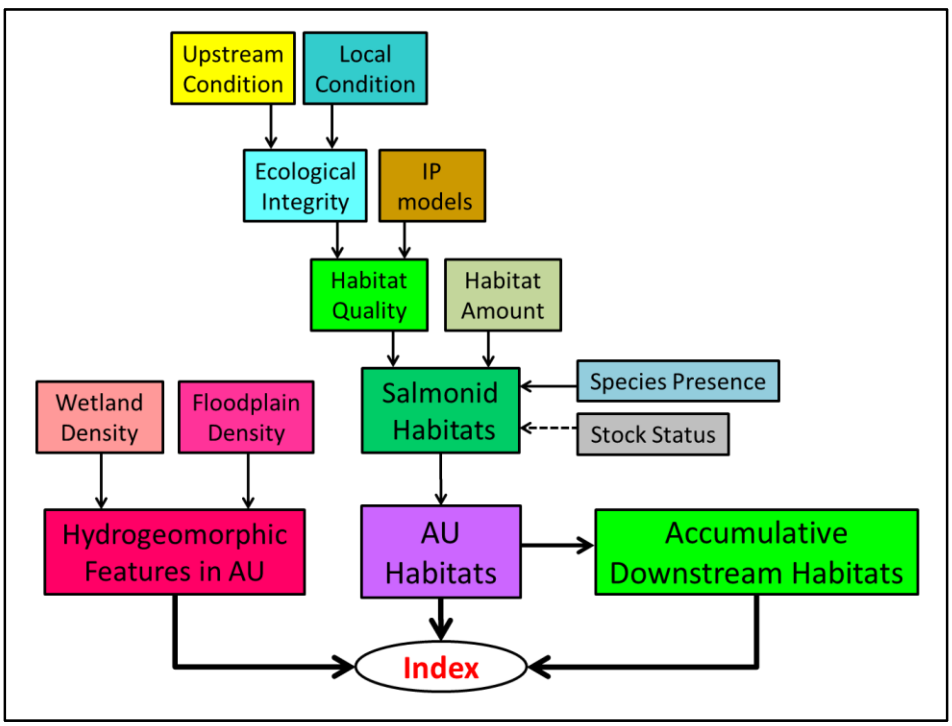



**Figure 9. Components of the relative conservation index for freshwater habitats.** The three main components are hydrogeomorphic features in the AU, salmonid habitats in the AU, and accumulative downstream salmonid habitats. The dotted line from the stock status indicates that this component was optional. Stock status was used in this assessment which focused on the salmonid habitats index. IP = Intrinsic potential.

On the next tier the main component is salmonid habitats, which the Lead Entity for WRIA 7 determined would be the most useful for providing a multi-species “lens” by which to identify high priority AUs. Within this component separate calculations are done for eight salmonid species. The relative value of each salmonid habitat is a primarily a function of habitat quality and habitat amount, but it is also influenced by species’ presence, and optionally, the species’ status. Salmonid *habitat quality* is a function of intrinsic potential (IP) and aquatic ecological integrity, which address the intrinsic and extrinsic attributes of freshwater salmonid habitats, respectively. Ecological integrity of an AU depends on conditions within that AU and on conditions upstream of the AU. Because of the spatial scale of the assessment and the available data, AU and upstream conditions must be based on land use and land cover.

We assume the habitat occupied by salmon is more valuable than unoccupied habitat. Hence, salmonid *habitat value* combines reach habitat quality with species occurrence information for each reach. Our fish occurrence data have three categories of presence – documented, presumed, and potential – that reflect the level of certainty regarding species occurrences. Certainty of species occurrence affects habitat value. Species status could be another factor affecting habitat value, however, because incorporating species status into the assessment entails a policy decision, this factor is optional. The WRIA 7 lead entity chose to include species status in the calculation of habitat value.

There are several ways an AU can be highly valuable for the conservation of salmonid habitats – when the AU contains exceptionally high quality habitat for only one species; contains large amounts of habitat for many species, regardless of habitat quality; contains some intermediate amounts of high quality habitats for some species, or contains large amounts of moderate quality habitats for some species, etc. In other words, conservation value is a function of the quantity and quality of habitats and species richness. Our index must incorporate all three of these aspects of conservation value.

Another way that an AU can be valuable for the conservation of freshwater lotic habitats is its potential impact on downstream habitats. AUs that could potentially impact large amounts of high quality habitat should be protected in order to avoid or minimize adverse impacts on those downstream habitats. For each AU, our index quantified the value of downstream habitats.

There are two basic perspectives on modeling the relative conservation value of places, and they reflect a quantity versus quality dichotomy. One perspective is that conservation value is best determined by a place’s total contribution to habitat conservation, in other words, the quantity a place contributes. The other perspective is that value is best determined by a place’s single most significant contribution, i.e., the quality a place contributes. These two perspectives can result in different rankings of places. For example, the former perspective would value a place with high species richness over a place with high species rarity, while the latter would value rarity over richness. Neither perspective should be ignored, so we examined relative conservation value both ways.

### Components of the Freshwater Habitats Indices

The main components of the freshwater habitats indices are 1) the density of wetlands and undeveloped floodplains, 2) local salmonid habitats, and 3) accumulative downstream habitats (Figure 9). For the assessment performed for this report local salmonid habitats, including stock status, was used to provide a habitat "lens" to integrate with the water flow and sediment process degradation results.

#### Hydrogeomorphic Features

Spatial data for wetlands was obtained from Department of Ecology (Stanley et al. 2011). We refined the wetland data layer by overlaying it with a land cover/land use data layer (C-CAP 2006) and removing wetlands co-incident with urban or agricultural land uses. The area of functional floodplains was calculated by removing areas that were co-incident with "developed" land uses in C-CAP. The percent area of hydrogeomorphic features in an AU was calculated as area of undeveloped floodplains plus the area of wetlands outside of floodplains divided by AU area.

#### Local Habitats

Local or watershed habitat value (also known as AU habitat value) was a function of habitat quality, habitat amount, presence category, and species and stock status. WDFW's FishDist database was the source of all spatial data on the presence of salmonids in rivers and streams. FishDist data for 10 salmonid species and life-history variants – Chinook, coho, pink, chum, sockeye, kokanee, steelhead, rainbow trout, cutthroat, and bull trout – were transferred to reaches in the NetTrace channel network. For the purposes of this analysis, we equated presumed presence with documented presence but assigned lesser value to water bodies where a salmonid species had potential presence. To simplify the analysis we lumped kokanee with sockeye, and where steelhead and rainbow trout co-occur we lumped them together also.

Habitat quality was the weighted geometric mean of intrinsic potential (IP) and ecological integrity. We currently have IP models for steelhead, coho, and Chinook. The steelhead model was also applied to rainbow trout. For those salmonid species that lack an IP model, intrinsic potential was set equal to 1, and consequently, habitat quality was only a function of ecological integrity.

None of the IP models we utilized for this assessment were developed specifically for Puget Sound salmon populations, and IP models specifically for Puget Sound salmonid populations are likely to be different. However, we believed that the available models were adequate for our purpose; namely, to calculate watershed-scale estimates of relative conservation value and make valid distinctions among AUs.

To develop our index of aquatic ecological integrity we utilized two studies that found significant relationships between indices of biological integrity (IBIs) and the proportion of a watershed covered by certain land covers or land uses: Mebane et al. (2003) and DeGasperi et al. (2009). Both DeGasperi et al. (2009) and Mebane et al. (2003) performed straight line regressions on their data. We conducted our own analyses and found for both sets of data that better fits were obtained with power functions. We used these new relationships in our calculation of ecological integrity. Our index of aquatic ecological integrity is ultimately based on land cover. The three "predictor" variables for ecological integrity were percent of a watershed covered by impervious surface; percent of a watershed not covered by forest, wetlands, or natural vegetation; and percent of a watershed covered by human disturbances (e.g., urban, residential and agricultural).

The ecological integrity of aquatic habitats is governed by processes occurring both locally and remotely. Hence, we applied the ecological integrity functions to six zones that divided a drainage area along both lateral and longitudinal dimensions (Figure 10). The two lateral zones were floodplains/riparian areas and uplands. The three longitudinal zones were: 1) the focal AU, 2) AUs immediately upstream of the focal AU, and 3) all other AUs in the upstream drainage area of the focal AU. Ecological integrity index values calculated for these six zones were combined with a weighted arithmetic mean to yield a composite ecological integrity (CEI) index for each AU.

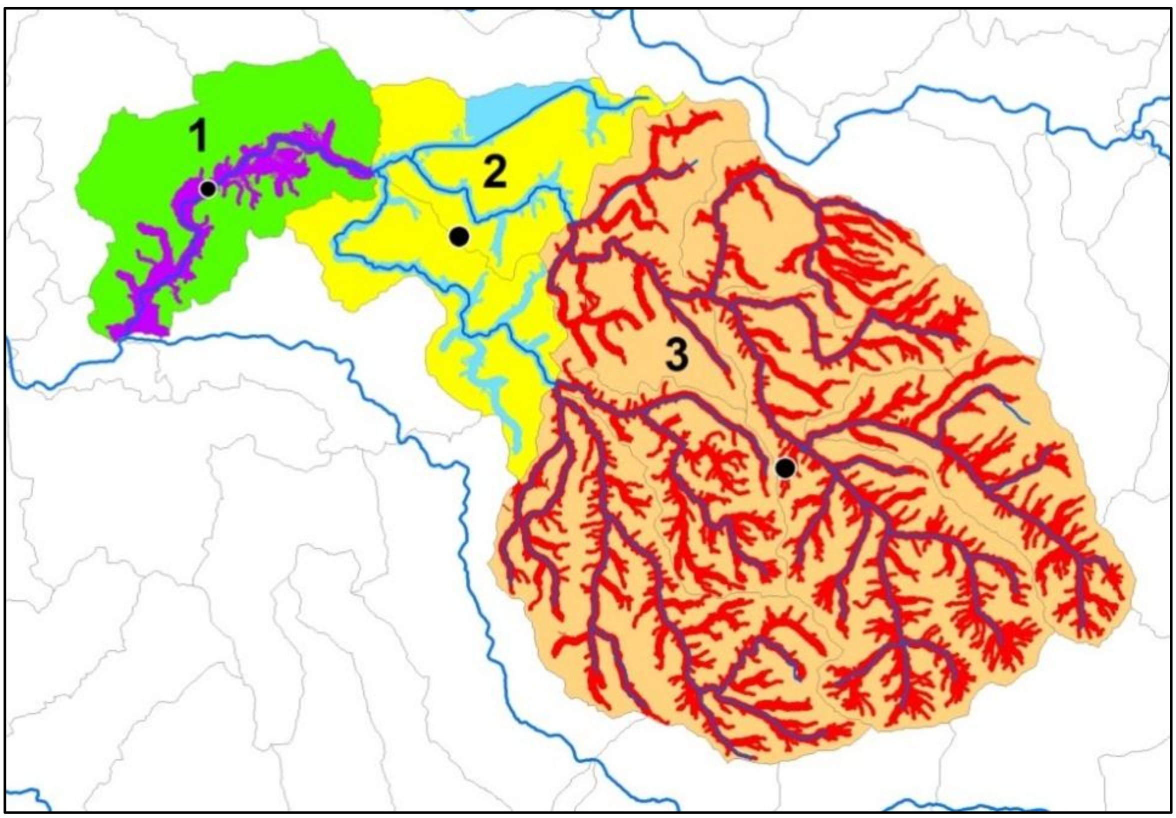



**Figure 10. Six zones for which aquatic ecological integrity was calculated.** The drainage area of each AU was divided into three sub-areas: 1) the focal AU, 2) AUs immediately upstream of the focal AU, and 3) all other upstream AUs. These subareas were further sub-divided into floodplains/riparian areas (purple, blue, and red) and uplands (green,yellow, and red). The index values calculated for the six zones were combined through a weighted arithmetic average to yield the aquatic ecological integrity of the focal AU. Black dots represent the mean distance of each sub-area from Puget Sound. Gray lines are AU boundaries and blue lines are rivers and streams. Only rivers and streams mapped 1:24,000 are shown.

Habitat value equals habitat quality combined with species presence category and optionally the species and stock status. For this assessment we included species and stock status as factor affecting habitat value. Habitat value is calculated for each species present in a reach. Hence, up to eight values per reach must be summarized into a single value. We derived two separate indices that combine the eight values: the maximum habitat value per reach and the sum of the habitat values times the habitat amount (i.e., reach length). Habitat value times habitat amount equals habitat units. A reach contributes the largest amount of habitat units when it is long and has high habitat value, but exceptionally long reaches with low habitat value and short reaches with exceptionally high habitat value can also contribute a large amount of habitat units.

Using only one of the two metrics would fail to identify many high value reaches. Maximum habitat value identifies reaches that contain exceptionally high quality habitat for only one species, while the sum of habitat units identifies reaches with a large amount of habitat for many species. Hence, the reach habitats index (RHI) is the maximum of the two metrics and is used in the calculation of accumulative downstream habitats.

Hence, the reach-scale habitat values and habitat units must be combined to yield a watershed-scale index. The watershed habitats index (WHI) for an AU equals the maximum of either the sum of habitat units for all stream reaches in the AU or the sum of habitat units for reaches in that AU with a maximum habitat value greater than the 90$^{th}$ percentile habitat value for the WRIA where the AU is located. In other words, WHI assigns a high value to AUs that either have a relatively large amount of habitat units or have a relatively large amount of high value habitat.

Before applying the maximum function, the two components of WHI were divided by AU area to yield a habitat unit density and normalized by their respective maximum values within the WRIA. For the WRIA 7 assessment we provide mean WHIs for planning units and basins, The mean WHI was calculated as an area weighted average of WHI values for AUs with the planning unit or basin.

#### Accumulative Downstream Habitats

The calculation of the accumulative downstream habitats component of an AU's relative conservation value was done in two steps. First, for each reach, RHIs for all downstream reaches were summed (Figure 11). M2 Environmental Services created a computer program that performed this operation. Second, the reach-level accumulative downstream habitats values were averaged within each AU.

### The Indices of Relative Conservation Value

We have three components with which to calculate an index: hydrogeomorphic features, local habitats (WHI), and accumulative downstream habitats (Figure 9). The index is simply a sum of the three components. For the purposes of combining these three components, their values were first converted to quantiles. In all analyses the quantiles were deciles.

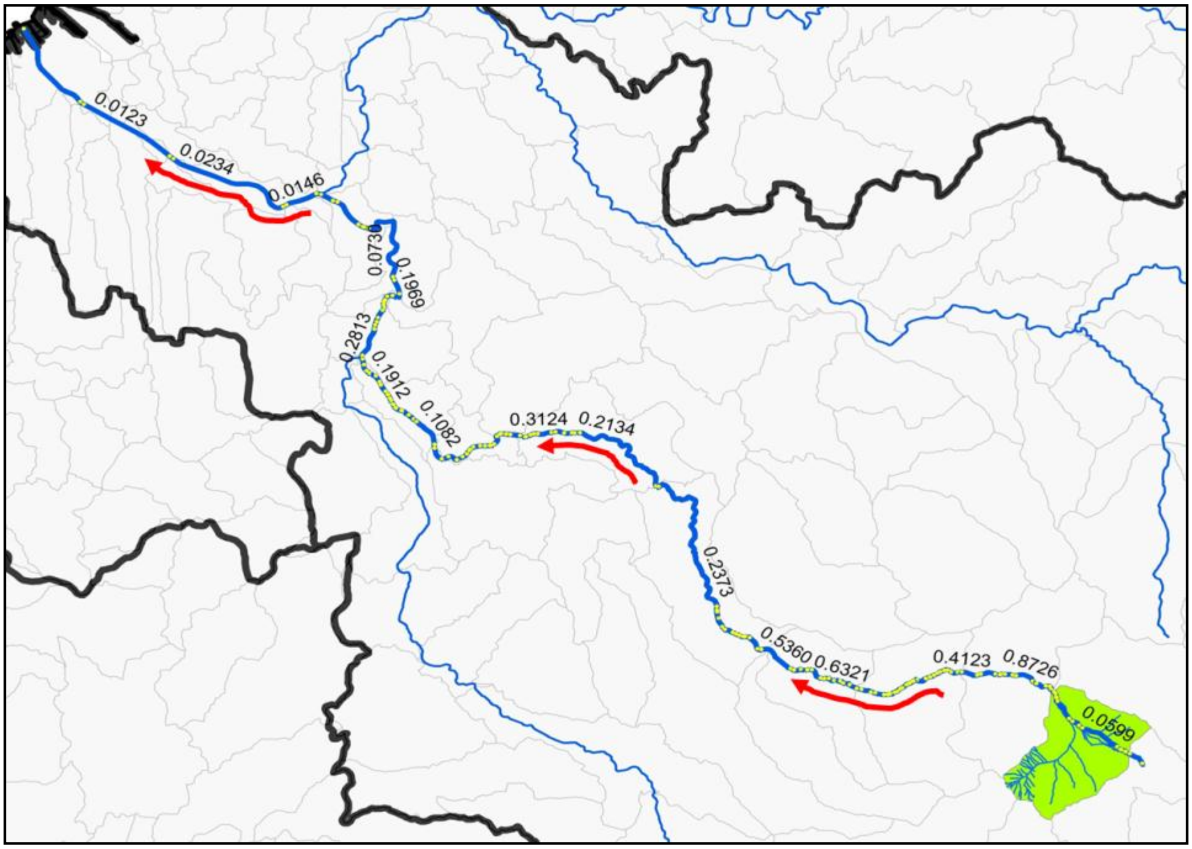



**Figure 11. The accumulative downstream habitats (ADH) component of the index of relative conservation value.** ADH for the green AU is the sum of RHI values downstream of the AU. Yellow dots mark breaks between adjacent stream reaches, and numbers are hypothetical RHI values for each reach. Gray lines area AU boundaries, thick black lines are WRIA boundaries, and blue lines are rivers.

# The approach used to identify priority watersheds and actions

## Multiple scales of assessment

The following sections summarize the results of the water flow, sediment, and salmonid habitat assessments. We compare results for each assessment at multiple scales to inform different types of decisions. All assessment results (water flow, sediment and WHI) are summarized first at the WRIA extent (scale 1) which compares the three basins within WRIA 7 (Lower Snohomish, Snoqualmie, Skykomish) for their relative value. Subsequently, assessment results are summarized at the basin scale (scale 2), which compares water flow recommendations across planning units (e.g. Tolt River). At the planning unit scale (scale 3), we identify specific AUs which have been filtered out as a high priority for water flow processes. Management considerations at scale 3 identifies those high priority AUs which may provide different opportunities for protection based on all three assessments (water flow, sediment and salmonid habitats).

Several important concepts to note:

1. The planning units along the river mainstem reaches (mainstem Snohomish, mainstem Snoqualmie, mainstem Skykomish) do not have scale 3 summaries as the focus of the WRIA 7 Protection Plan is to identify important areas out of the mainstem for protection actions.

2. Assessment results for water quality (sediment process degradation) and salmonid habitats (including stock status) were calculated only at scale 1(WRIA wide), comparing all 268 AUs across WRIA 7. These scale 1 results are also used for more detailed summaries at scale 2 but do not represent a "re-run" of the assessment at these smaller extents as is the case with the water flow assessment, explained in number three. As such, AU results (quartile rankings of Low-High) for habitat and water quality, regardless of scale, can be directly compared to any AU within WRIA 7.

3. The water flow model re-ranks and bins AUs when run at the different scales. As a result, AU scores (rankings and binning AUs from High-Low) cannot be compared across basins or planning units at scales 2 or 3. The underlying "raw data" (e.g. % wetland cover) has not changed (except in Type II AUs explained below) but the High to Low position of an individual AU will potentially differ with a smaller set of comparable values. The Management Matrix for water flow (Protection & Restoration maps) also represents a re-sorting and categorization of AUs based upon the combination of water flow importance and degradation, given the different extent of comparison. Figure 12 below illustrates the three scales of comparison used in this report.

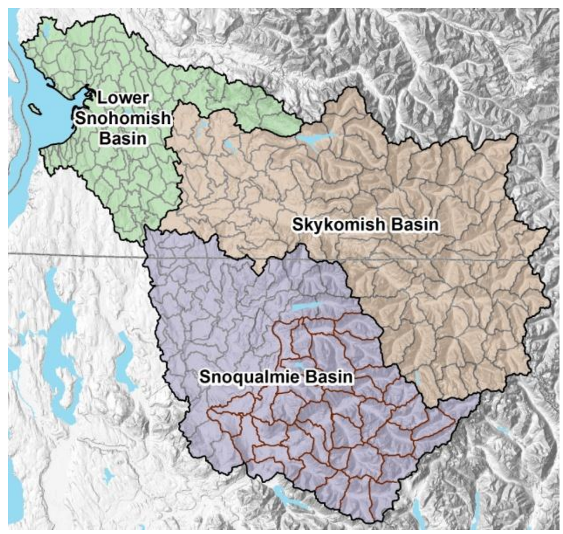
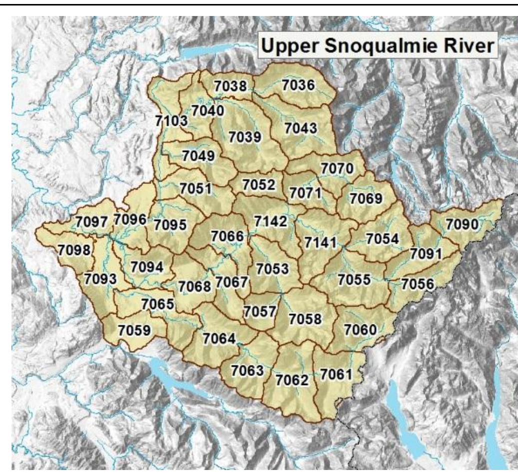
<table>
<tr><th>Assessment performed at each scale</th><th>Extent of comparison</th></tr>
<tr><td>Scale 1 - WRIA<br>-Water Flow assessment – compares all 268 AUs in WRIA to each other for relative ranking<br><br>-Sediment process degradation results – compares all 268 AUs in WRIA 7 to each other for relative ranking<br><br>-Local salmonid habitat results – compares all 268 AUs in WRIA 7 to each other for relative ranking</td><td>
</td></tr>
<tr><td>Scale 2 - Basins<br>-Water flow assessment - compares AUs within each of the 3 major basins for relative rank<br><br>-Sediment process degradation and local salmonid habitat results presented are from scale 1 assessment.</td><td>
</td></tr>
<tr><td>Scale 3 – Planning Units<br>- Water flow assessment - compares AUs within an individual planning unit.<br><br>-Sediment process degradation and local salmonid habitat results presented are from scale 1 assessment.</td><td>
</td></tr>
</table>

**Figure 12. The geographic extent of the three scales of comparison in this document for each assessment type.**

**Assessment Units**
Scale 3 assessment summaries for water flow processes feature one of two types of watershed delineations (see Figure 13). Type I has planning units which use the same assessment units as employed for scales 1 and 2 (e.g.Estuary Drainages). Type II delineations are those where the assessment units for a planning unit are broken into smaller assessment units because there are not enough for comparison at scale 3 (e.g. Raging River).

**Type I Assessment Units**
With Type I AUs, the scale 3 water flow assessment uses the original AU boundaries since the size of the planning unit and the number of AUs provide an adequate comparison for grouping the values from low to high. The left panel of Figure 13 shows an example of the Estuary Drainages planning unit with 18 AUs. In this case, the scale 3 results are based on <u>no</u> change in the raw score for an AU (e.g. % impervious surface) relative to scale 1 or 2 results. Rather, the scale 3 assessment compares the same raw scores, but among a smaller number of AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Snoqualmie) or WRIA. Thus, an AU may lie within the highest rank quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow (recall Figure 6) to help group the AUs relative to both their level of relative importance and level of relative degradation based upon the newly defined extent of comparison.

**Type II Assessment Units**
For Type II AUs (Figure 13 right panel), the original AU boundaries were further diveded given the small number of units within the planning unit, which are too few for comparison. The Raging River planning unit had three original AUs that were divided into 22 smaller units. These new AUs allow for a better comparison within the planning unit to identify high priority areas for water flow processes. Given the different delineation, these scale 3 results are based upon different raw values (e.g. % wetland area) than those for the Type I AUs. Five planning units used the Type II assessment units: Raging, Patterson, Cherry, Mid-Snoqualmie, and Lower Mid-Skykomish.

Note that the sediment degradation and local salmonid habitat assessments for scale 3 do not use the Type II delineations. As such, when identifying AUs most important to water flow in this type of planning unit, and linking them to those important for sediment or salmonid habitats, the relationship is not direct. Those areas in a watershed which may account for the AU’s score using the sediment or habitat results cannot be directly attributed to the same areas in the smaller, Type II AUs used to score water flow processes. Additionally, recall that the sediment and local salmonid habitat results presented in scale 3 summaries are those from the WRIA 7 scale assessment.

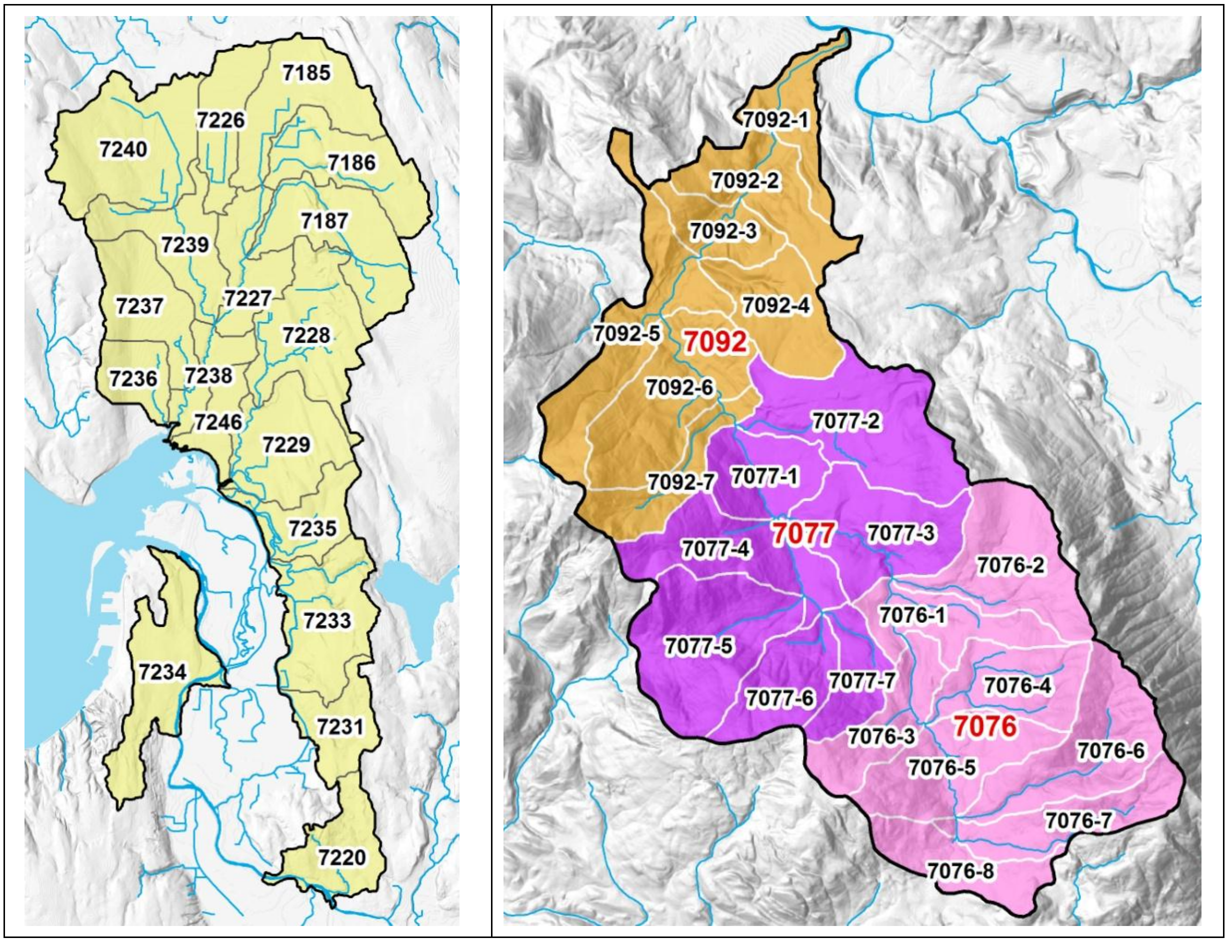



**Figure 13. Type I (left, Estuary Drainages) and Type II (right, Raging River) assessment unit (AU) delineations.** Type II delineations (white boundaries) nest within the original, larger Type I delineations (colored areas) and offer a greater number of assessment units to compare within a planning unit.

## Using different scales of analysis to support decision making

Each scale of assessment provides information to support a different set of comparisons. Figure 14 below summarizes the comparisons and uses at each scale of assessment. The WRIA-wide assessment results for water flow processes, sediment processes, and salmonid habitats are used to rank each basin (in scale 1 summary) in terms of its relative value, then each planning unit (in scale 2 summaries). This helps with broad, WRIA or basin wide decisions regarding where to focus resources to target protection of those processes and habitats. These rankings are summarized in tables provided for each scale 1 and 2 summary section.

### Process for ranking basins and planning units

Water Flow rankings are based upon mean rank of all AUs in a basin or planning unit where the highest ranking AU is assigned 1 and lowest ranking AU is assigned 268 (where n = 268). Sediment degradation rankings are based upon mean rank of all AUs in a planning unit or basin where the highest ranking (most degraded) AU is assigned 1 and the lowest ranking AU is assigned 268. Habitat rankings are based upon the rank of the area weighted mean habitat value (i.e., WHI) of all AUs in each basin or planning unit.

<table>
<tr><th>Assessment scales and uses in the report</th><th>Watersheds</th></tr>
<tr><td>

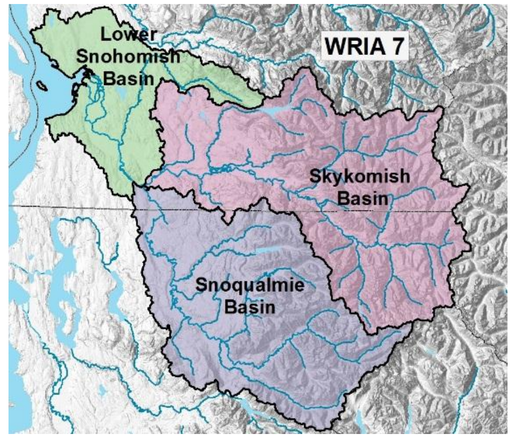
**Scale 1 - WRIA**

-Water Flow assessment results compare basins and planning units by average AU rank.

-Sediment process degradation results compare basins and planning units by average AU rank. Highest ranked AUs are used in scale 3 integration to identify priority AUs.

-Local salmonid habitat results compare planning units by area weighted mean.  Deciles 8-10 used in scale 3 integration to identify priority AUs.

</td><td>

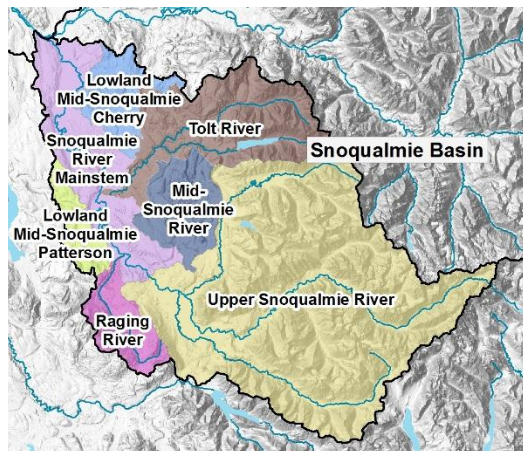



</td></tr>
<tr><td>

**Scale 2 - Basins**

-Water flow assessment at this scale identifies overall land use recommendations and priority subcomponents of the water flow process to prioritize for protection and restoration measures.

</td><td>




</td></tr>
<tr><td>

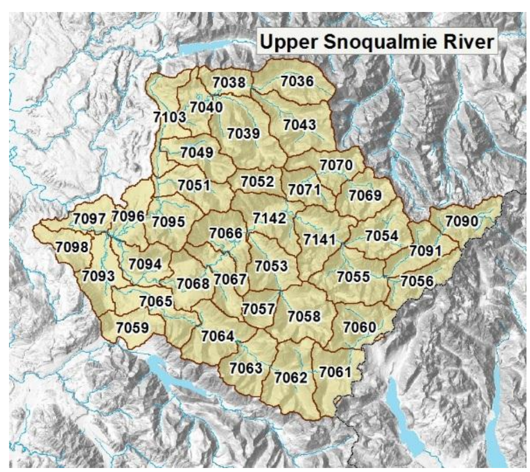
**Scale 3 – Planning units**

- Water flow assessment at this scale identifies the Highest ranked (top 25%) assessment units for overall importance to water flow processes. Degradation results group priority AUs into protection and restoration categories.

- Sediment process degradation results identify assessment units which may be degraded to a point where protection efforts could be undermined.

- Local salmonid results identify which assessment units, if protection measures are implemented, might benefit high quality salmonid habitat.

</td><td>




</td></tr>
</table>

**Figure 14.  The three scales of water flow assessments inform different aspects of land use decision-making.**

**Determining Land Use Recommendations and PriorityAreas for Protection & Restoration of Water Flow Processes**

Recall that the sediment process degradation and salmonid habitats assessments were only performed at the WRIA-wide extent, though summarized in finer detail at the basin (scale 2) extent and used in scale 3 summaries to prioritize individual AUs for protection. In contrast, the water flow assessment was performed at two additional scales to utilize the Management Matrix to categorize planning units, inform general land use recommendations, and identify specific components of the water flow process to prioritize for restoration or protection. The scale 3 assessment for water flow was used in planning unit summaries to identify priority AUs for protection and is discussed in the following section.

The process for determing land use recommendations and priority subcomponents of the water flow process is a qualitative exercise. This approach uses the assessment results and Management Matrix as a diagnostic tool. The Matrix helps evaluate the water flow assessment for both relative importance and degradation across a watershed or basin which contains multiple AUs. The intent of these recommendations is to tell the "story" of a watershed. The story can guide land use decisions and help prioritize protection of different features and controls on the important water flow processes in a given set of AUs.

In using the water flow results as a diagnostic tool it is important to select a scale or extent of assessment which captures the typical range of degradation in a particular land use setting. It is difficult to derive recommendations from this relative comparison of watershed features using the WRIA-wide results because the range of land uses varies from highly urban to agricultural dominated, to forestry based. When an AU is ranked as highly degraded, it is difficult to infer if this is due to urban activities such as high intensity development, or if it is due to agricultural activities in floodplain areas, or from intensive forestry practices. Conversely, selecting too small a scale can lead to inferring a larger range of degradation than is ecologically significant due to the process of categorizing AU rankings into quartiles.

For example, under the scale 1 WRIA assessment, the water flow results may show that a mountainous watershed with working forests has a low level of degradation relative to urban watersheds. However the scale 3 assessment can show the same AUs ranking highest for degradation and this can be interpreted to be due to impacts such as forest roads or forest clearing, which are significant threats to the integrity of that watershed. Selecting a scale in which the range of degradation does vary along an ecologically significant gradient, but is likely due to only a few different types of human activities allows one to more readily infer the cause of the degradation without more extensive analyses of the base GIS layers. A more detailed analysis of the data is always possible, and in cases where high levels of certainty or accuracy are needed, advisable. However, the intent with this approach is to provide a quick, coarse-scale snapshot of the watersheds to guide planning and prioritize further analyses and so maintains utility to certain users.

For the purposes of this report we have decided that scale 2 assessment results will be used to make the land use protection and restoration recommendations. This was determined to be the scale that provided the best differentiation of AUs based upon the unique land use characteristics of each of the three major basins in WRIA 7. A combination of both scale 1 and 2 results can provide additional insight into potential land use and protection priorities but was not performed here.

If an entity is prioritizing protection actions in a planning unit that are intended to address *all* water flow processes, such as questions about where to increase or decrease population density, consult the overall importance to water flow map. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process. If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in a planning unit, the scale 2 results can help identify this. Then the scale 3 results can specifically target a selection of AUs in the planning unit.

To demonstrate how we interpret the overall and submodel results for water flow processes at scale 2, we present the following steps of analysis based on a hypothetical example:

1. Overall water flow Results. Look for predominant areas (multiple AUs) of high scoring (Highest Protection and Highest Restoration categories from the Management Matrix) AUs in a basin or watershed. This provides general, broad scale guidance to planning decisions related to land use intensity. In further steps of a decision-making process it is important to ask what type of land use activities are most suitable given the landscape context?

2. Examine submodel Results. Look for which submodel (delivery, surface storage, recharge, discharge) maps illustrate a large area of AUs ranked highest for protection or restoration within a planning unit or basin. This provides an idea as to which subcomponent of the water flow process may be having greatest effect on the overall water flow scores and which are highly ranked in that basin. This can help identify what type of land use management actions (protection or restoration based activities) are most likely to address the process based needs of that basin.

   To take this step further and target more specific actions - determine which model indicators are involved in those high priority subcomponents. This suggests which land use factors are controlling the higher scores for protection and restoration and what types of actions may help water flow processes. For example:

   - If the delivery submodel shows large area ranked high for importance - this suggests that precipitation is driving factor for water flow processes in this area relative to other assessment units.
   - If the delivery submodel also shows a large area ranked high for degradation, and the predominant land use in the watershed is forestry– this suggests that forest clearing has contributed to the degradation and actions which reduce or restore this should be considered.

Once priority water flow components for protection or restoration have been determined see the Management Recommendations for Water Flow. This section offers broad scale recommendations as to the type of actions which might be taken to address the specific process in different land use settings. The land use recommendations provided in this report can be used to inform planning level decisions for comprehensive and sub area plan updates, or to establish broad protection and restoration strategies by NGOs, Salmon Recovery groups or other natural resource planners.

**Determining highest priority assessment units in the planning unit summaries**

As described above, scale 3 assessments are not as helpful when used as a diagnostic tool for determining what the priority actions for protection and restoration of water flow processes should be. However, the scale 3 results can be used to determine, specific to a planning unit, *where* to focus protection actions for specific water flow processes which were most appropriately determined at larger extents (e.g. scale 2). Scale 3 assessments for water flow nest within the larger scale basin analyses and provide additional geographic detail on the best locations for land use actions. It is important to keep in mind that scale 3 results should always be used within the context of the larger scale results when developing overall planning recommendations.

The SBPP Project Team chose to integrate the local salmonid habitat (i.e.WHI) component with the water flow and sediment degradation assessments. The watershed habitats index (WHI) evaluates a watershed for its relative quality and quantity of stream miles important to salmonids.

This report is to support the purpose of the SBPP in the *identification of:*

> *1) priority areas to protect hydrologic processes that support salmonid habitat in the watershed and,*
>
> *2) strategies to protect the hydrologic processes that support the salmonid habitat.*

Given this objective, we decided on the following four steps to identify specific AUs in the scale 3, planning unit summaries:

*Identifying highest priority AUs for water flow processes*

1. Use scale 3 water flow results to identify all AUs in the planning unit which rank Highest (top 25%) for water flow processes. These are the highest priority AUs for protection of hydrologic processes. *Note – we have made the decision to focus on the top 25% of AUs however this represents a somewhat arbitrary threshold by which to identify priorities. The SBPP Project Team and other users of the information may move this threshold based upon local conditions, changing goals or other considerations.*

*Identifying management considerations based upon subsets of assessment results*

2. Group AUs identified in (1) based upon their relative level of water flow degradation into two categories A) Protection group, and B) Restoration group; where (B) AUs are those which rank in the top 50% of all AUs in that planning unit for degradation to water flow, and (A) AUs are those which rank in the lowest 50% of all AUs in that planning unit. Based on the decision of the WRIA 7 technical committee as stated above *this grouping does not imply different levels of priority for protection*, but rather groups the AUs in such a way that can help determine what type of protection measures may be most appropriate. We call these Protection or Restoration groups. *Note – we made the decision to group the AUs based upon the 50% highest/lowest rankings, however this represents a somewhat arbitrary threshold. The SBPP Project Team and*

*other users of the information may move this threshold based upon local conditions, changing goals or other considerations.*

3. Identify which AUs in (A above) rank in the highest priority (8-10 deciles) for local salmonid habitats. These AUs may contain significant salmonid habitats (quality and quantity) and species presence which warrant protection. *Note – we made the decision to identify the AUs based upon the 8-10 deciles, however this represents a somewhat arbitrary threshold by which to identify priority salmonid habitats. The SBPP Project Team and other users of the information may move this threshold based upon local conditions, changing goals or other considerations.*

4. Identify which AUs from (A above) rank highest for sediment degradation. These AUs may contain significant sediment process degradation which could undermine the protection of salmonid habitats. *Note – we made the decision to identify the AUs based upon top 25% of the ranked values. However this represents a somewhat arbitrary threshold by which to identify AUs which may present significant challenges to protecting salmonid habitat based upon degradation to sediment processes. The SBPP Project Team and other users of the information may move this threshold based upon local conditions, changing goals or other considerations.*

The result of these four steps is a categorization of high priority AUs based upon the combination of conditions as described above. The first step identifies *where* high priority areas are more likely needing protection of hydrologic processes. By integrating the other assessments (sediment and salmonid habitats) to create categories of conditions, one can determine general management considerations when considering an AU for protection measures (i.e. w*hat* to do).

Table 5 is an example of the scale 3 integration table used to identify and group the highest priority assessment units. Figure 14A is an illustration of the results presented in the table.

**Table 5. Priority assessment units for water flow in the North Fork Skykomish planning unit. Figure VI is an illustration of the results presented in this table.**

| ***Where?*** | |
|---|---|
| **Protection Group (AU id)** | **Restoration Group (AU id)** |
| 7008 | (-)7010*, 7108, (-)7135 |
| ***What*?**<br>**Management considerations** | |
| Highest priority AUs which have lower relative degradation in the planning unit. | Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) indicates high potential for degraded sediment processes which could undermine protection of salmonid habitats.*Indicates high relative salmonid habitat value in AU. |

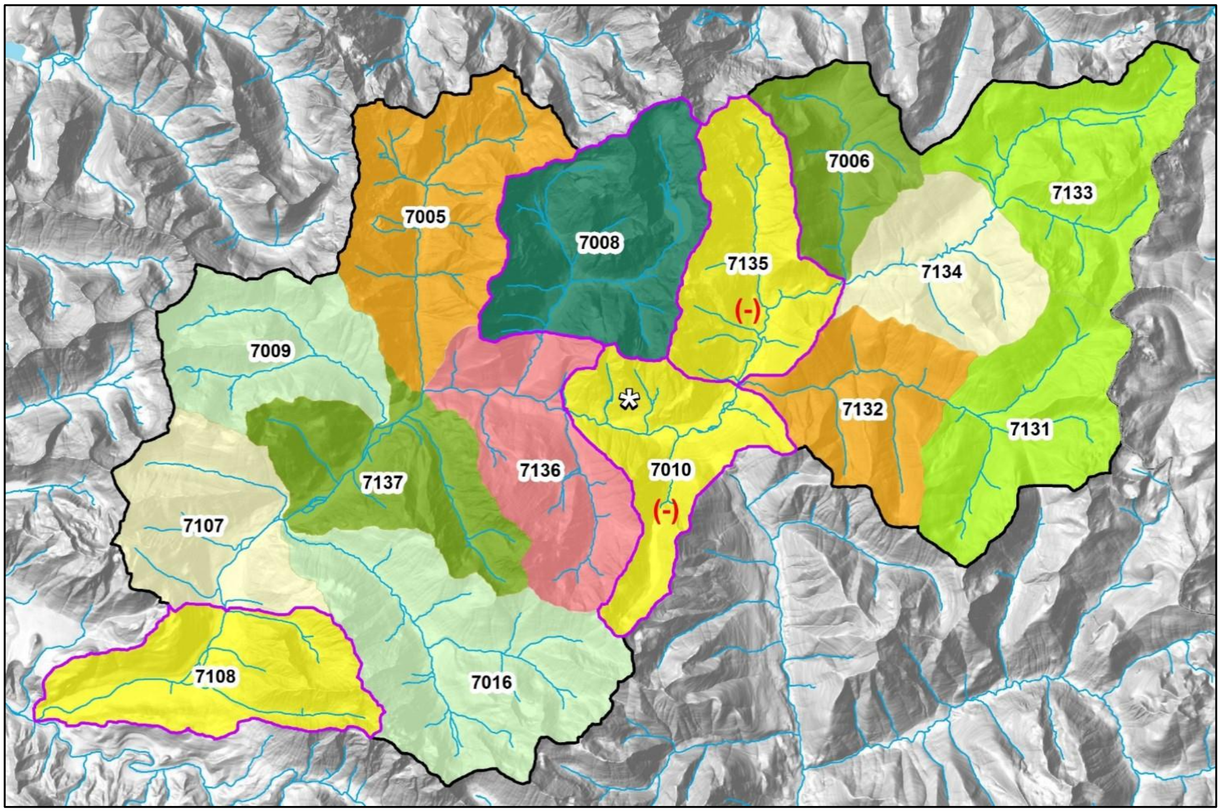



**Figure 14A. Scale 3 priority assessment units (AUs) for water flow processes in the North Fork Skykomish planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. An asterisk (*) indicates the AU meets the cutoff threshold for local salmonid habitats. A minus (-) indicates the AU meets cutoff threshold for sediment process degradation.

# Scale 1 WRIA 7 Summary

WRIA 7 (Figure 15) is comprised of the mainstem Snoqualmie and Skykomish basins which combine to form the Snohomish mainstem. WRIA 7 also includes the nearshore estuary drainages (Quilceda and Allen creeks) and Puget Sound shoreline drainages which drain directly to Possession Sound.

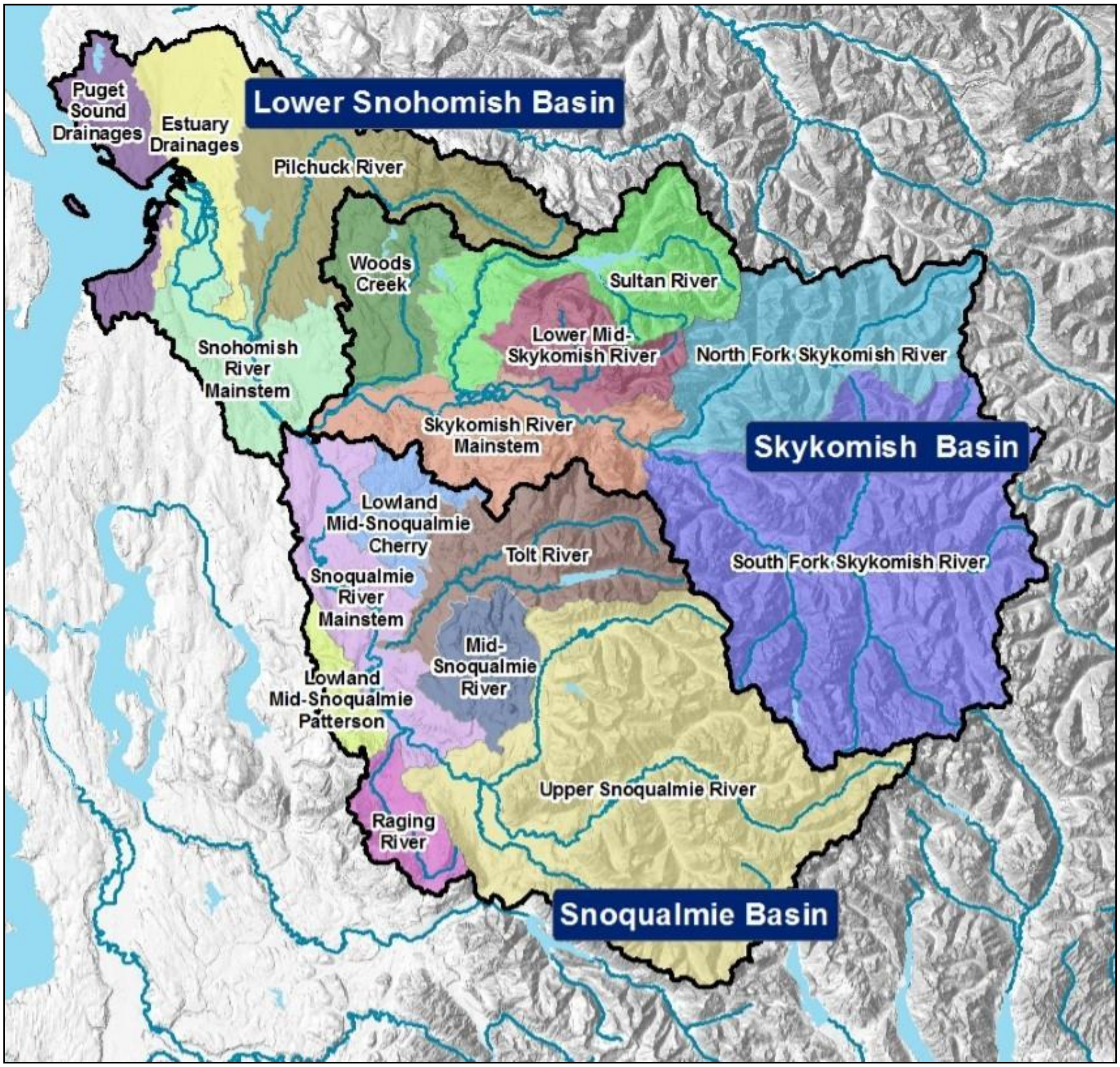



**Figure 15. Water Resouces Invintory Area (WRIA) 7, the three major basins, and planning units used in the assessment.**

# Water Flow Assessment for WRIA 7

The results of the water flow assessment for WRIA 7 (see Figure 16) compare all of the AUs in the WRIA to each other for their relative importance and degradation. AU scores or ranks are directly comparable across the entire WRIA. Following is a description of the assessment results for importance and degradation to water flow processes for WRIA 7.

**Overall Water Flow**

Across WRIA 7 the highest ranked AUs for relative importance to overall water flow processes (model 1- combining delivery, surface storage, recharge and discharge subcomponents) generally occur in the upper watersheds of the Snoqualmie and Skykomish basins (Figure 17). In particular, the Upper Snoqualmie, South Fork Skykomish, and North Fork Skykomish planning units contain significant numbers of AUs ranked highest or moderate-high for importance to overall water flow processes. The Lower Snohomish basin ranks lowest relative to the other two basins, though there are some AUs ranked highest for importance in the lower reaches of the Snohomish mainstem planning unit.

Across WRIA 7, the highest ranked AUs for relative degradation to overall water flow processes (model 2) generally occur in the lowland and mainstem of the Lower Snohomish basin (Figure 18), including the Estuary Drainiages and Puget Sound Drainages. Some AUs ranked moderate-high to high for degradation occur in and around the mainstem Snoqualmie, Upper Snoqualmie, and mainstem Skykomish planning units. In general, the Lower Snohomish basin is ranked highest for overall degradation, with the Snoqualmie basin ranked second, followed by the Skykomish, based on relative area of highest ranked AUs for degradation to water flow processes (see Table 6).

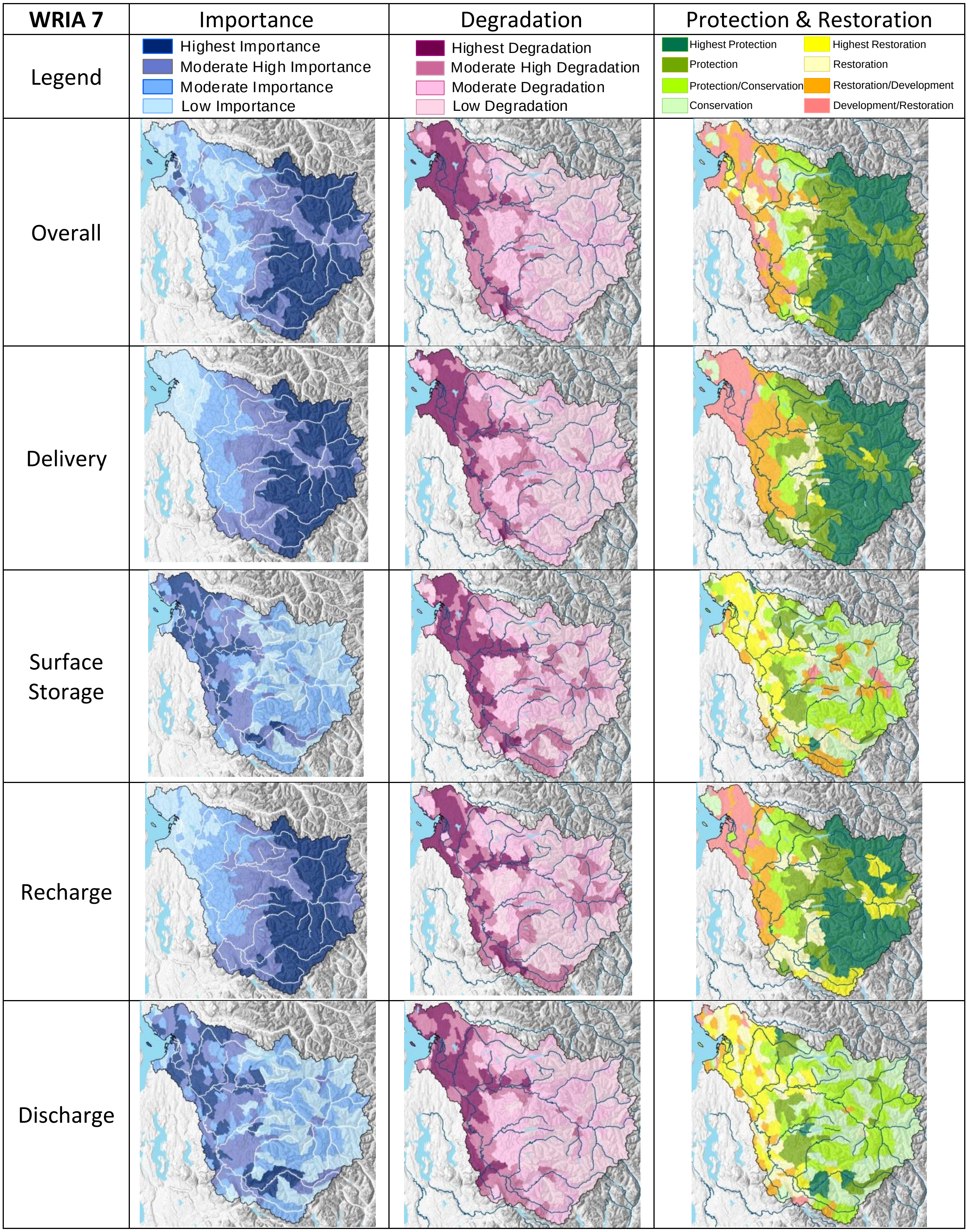



**Figure 16. Scale 1 water flow assessment results for WRIA 7.**

**Table 6. Comparison of average rankings across plannning units (scale 3) and basins (scale 2) for importance and degradation to water flow processes.** Rankings are based upon WRIA 7 (scale 1) assessment results (n=268). Assessment units ranked highest received a 1. Therefore, planning units which average a lower numeric value indicate higher relative importance, or higher relative degradation in comparison to higher numeric values.

| | | | Overall Importance to Water Flow | | | Overall Degradation to Water Flow | | |
|---|---|---|---|---|---|---|---|---|
| Basin | Planning Unit | # of AUs | Average AU Rank WF_M1 | Basin Rank | WRIA Rank | Average AU Rank WF_M2 | Basin Rank | WRIA Rank |
| Skykomish River basin | Lower Mid-Skykomish River | 7 | 132 | 4 | 6 | 177 | 4 | 13 |
| | Skykomish River Mainstem | 14 | 145 | 5 | 8 | 135 | 2 | 8 |
| | Sultan River | 12 | 117 | 3 | 4 | 172 | 3 | 12 |
| | North Fork Skykomish River | 15 | 40 | 1 | 1 | 238 | 6 | 16 |
| | South Fork Skykomish River | 38 | 60 | 2 | 2 | 212 | 5 | 15 |
| | Woods Creek | 10 | 196 | 6 | 15 | 112 | 1 | 7 |
| | *basin* | *96* | *115* | | | *174* | | |
| Lower Snohomish River basin | Estuary Drainages | 18 | 193 | 3 | 14 | 31 | 1 | 1 |
| | Pilchuck River | 26 | 175 | 2 | 10 | 100 | 4 | 5 |
| | Puget Sound Drainages | 25 | 243 | 4 | 16 | 67 | 3 | 3 |
| | Snohomish River Mainstem | 19 | 137 | 1 | 7 | 45 | 2 | 2 |
| | *basin* | *88* | *187* | | | *61* | | |
| Snoqualmie River basin | Lowland Mid-Snoqualmie | 11 | 192 | 6 | 13 | 103 | 2 | 6 |
| | Mid-Snoqualmie River | 5 | 181 | 4 | 11 | 165 | 5 | 11 |
| | Raging River | 3 | 165 | 3 | 9 | 139 | 3 | 9 |
| | Snoqualmie River Mainstem | 15 | 182 | 5 | 12 | 85 | 1 | 4 |
| | Tolt River | 12 | 128 | 2 | 5 | 156 | 4 | 10 |
| | Upper Snoqualmie River | 38 | 63 | 1 | 3 | 184 | 6 | 14 |
| | *basin* | *84* | *152* | | | *139* | | |

## Delivery Processes

Highest ranked (moderate high – high) AUs for relative importance to delivery processes are predominantly located in the upper reaches of WRIA 7 in the Skykomish and Snoqualmie basins. The North Fork Skykomish, South Fork Skykomish and Upper Snoqualmie exhibit the greatest extent with AUs ranked highest for importance to delivery processes, with the Sultan and Tolt River also containing highest and moderately-high ranked AUs in significant proportions. This is generally due to higher levels of precipitation and significant areas of rain on snow.

Generally, the Lower Snohomish basin, including the Estuary Drainages and Puget Sound Drainages, ranks lowest across the WRIA for importance to delivery processes. Lower relative levels of precipitation and no significant areas of rain on snow zones result in this, with AUs ranked lowest to moderate for importance to delivery except for the upper watershed of the Pilchuck River which contains some AUs of moderate-high importance.

Highest ranked AUs for degradation to delivery processes are generally distributed widely across the lowland planning units of the Lower Snohomish basin and lower mainstem areas of the Snoqualmie and Skykomish basins due to increased impervious surface and forest loss. The Estuary Drainages, Puget Sound Drainages, mainstem Snohomish, lower watershed of the Pilchuck River, mainstem Skykomish and mainstem Snoqualmie planning units all rank highest for degradation to delivery processes. Large areas of moderate Degradation to delivery processes occur in the Woods creek, Tolt River, Patterson and Cherry planning units as well. Overall the Lower Snohomish basin ranks highest for degradation to delivery processes.

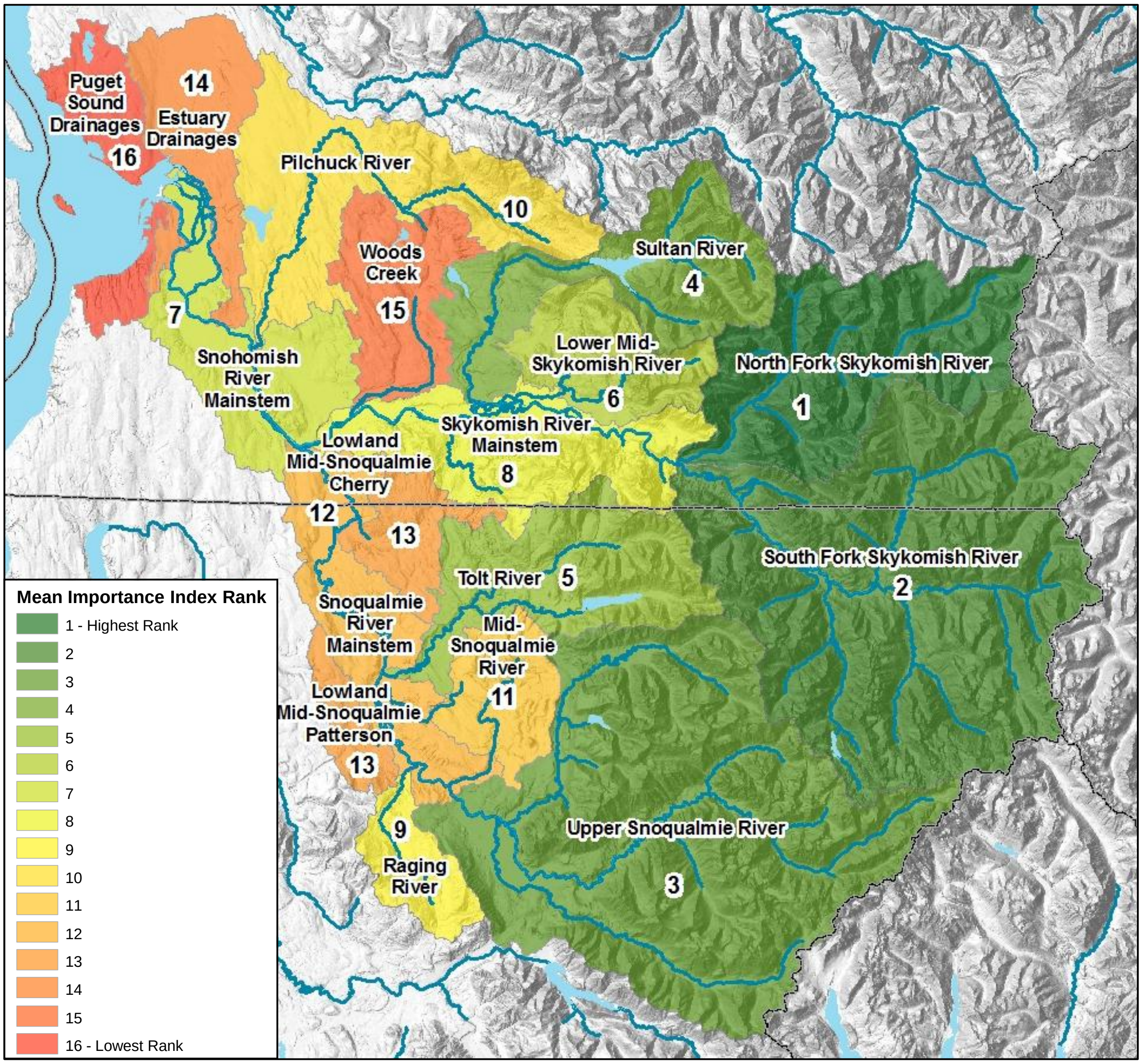



**Figure 17. Planning unit ranks for overall water flow importance.** Highest ranking planning unit is ranked 1, most important in the WRIA, and colored dark green.

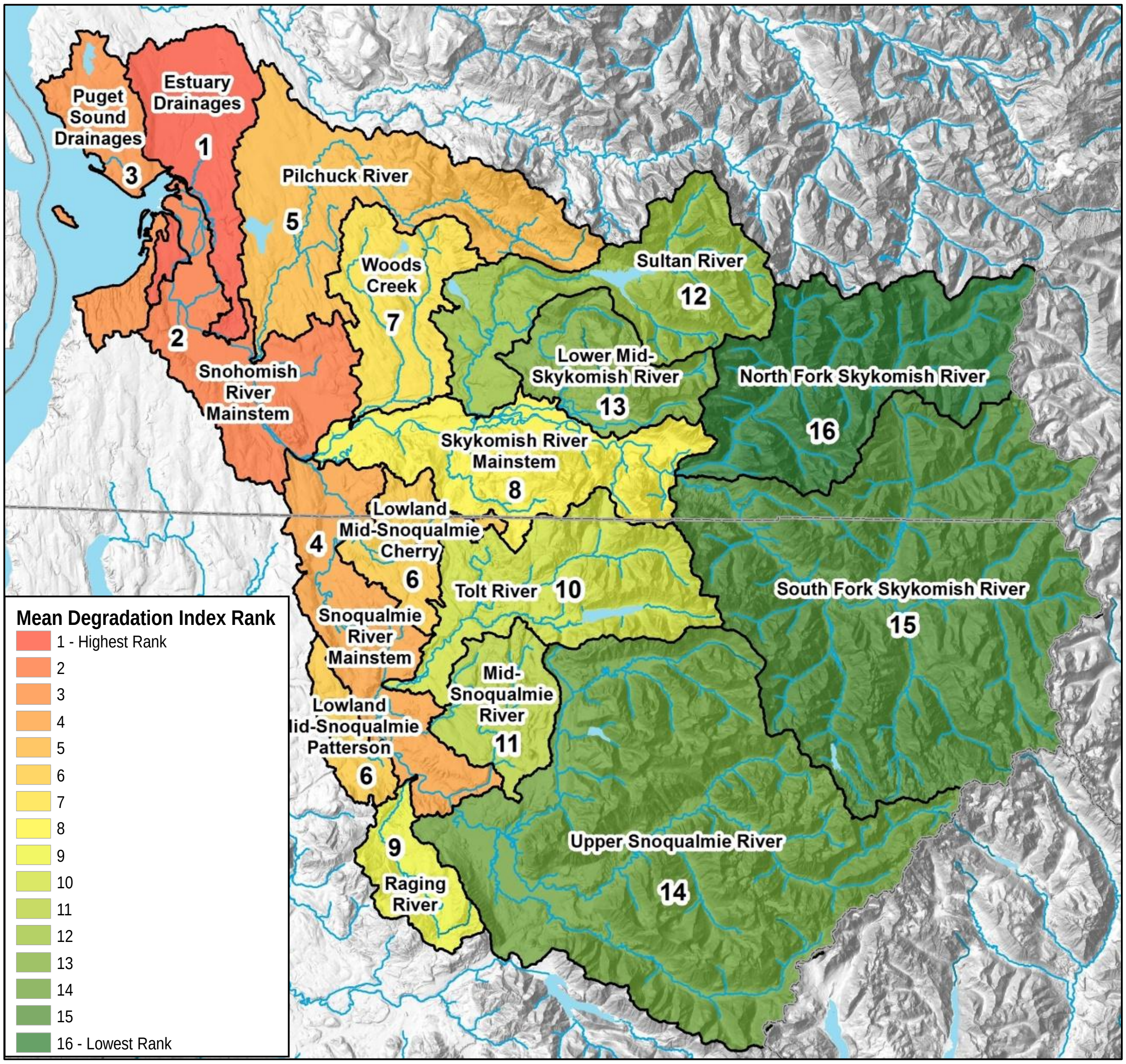



**Figure 18. Planning unit ranks for overall water flow degradation.** Highest ranking planning unit is ranked 1, most degraded in the WRIA, and colored red.

## Surface Storage

The Lower Snohomish basin contains the greatest relative extent of AUs ranked highest for importance to surface storage processes due to higher relative proportion of wetlands, lakes and floodplains in the Estuary Drainages, lower watershed of the Pilchuck, and mainstem Snohomish. The Snoqualmie basin ranks second for importance with high to moderate high AUs in the Cherry Creek, mainstem Snoqualmie, and upper Snoqualmie planning units. The Skykomish basin does contain areas of highest water flow importance in the mainstem AUs and lower watersheds of the Woods Creek, Lower Mid-Skykomish and Sultan River planning units.

The Lower Snohomish basin ranks highest for degradation to surface storage processes with the greatest relative area of AUs ranked highest due to channelization and disconnection of streams from floodplains and the diking, draining and filling of wetlands. Significant areas of highest ranked AUs for degradation also occur in the Skykomish mainstem, Snoqualmie mainstem, Upper Snoqualmie, lower Woods Creek, and Lower Sultan planning units.

**Recharge**

The Snoqualmie and Skykomish basins rank highest for importance to recharge processes in WRIA 7 with the greatest extent of highest and moderate-high ranked AUs. This is due to the higher relative precipitation and areas of high permeability surface deposits and soils. The Lower Snohomish basin generally has lowest to moderate ranked AUs for importance to recharge processes.

The Lower Snohomish basin is the most degraded for recharge processes with the greatest extent of AUs ranked highest due to impervious surface and higher intensity development on permeable surficial deposits. The Snoqualmie basin generally ranks second with significant impacts to recharge processes in AUs in the Snoqualmie mainstem, Patterson and Cherry Creeks, and Lower South fork of the Upper Snoqualmie planning unit. The Skykomish basin contains significant impacts to recharge processes with highest ranked AUs in the Skykomish mainstem, lower Woods creek, Sultan and Lower Mid-Skykomish planning units.

**Discharge**

The Lower Snohomish and Snoqualmie basins rank highest for importance to discharge processes due to the presence of slope wetlands and floodplains intersecting permeable deposits. The mainstem Snohomish, mainstem Snoqualmie, lower Pilchuck river, and Estuary Drainages planning units contain particularly large extents of high and moderate high importance AUs. Additionally the upper Snoqualmie, Skykomish mainstem, Lower Mid-Skykomish all contain AUs ranked highest and moderate-high for importance to discharge processes.

The Lower Snohomish and Snoqualmie basins rank highest for degradation to discharge processes due to more development within or adjacent to slope wetlands and floodplains with high permeability deposits, higher density of roads and ditches, and groundwater wells which impact those processes. Levees can also significantly impact discharge processes but were not modeled in the PSWC assessments due to incomplete GIS layer coverage across Puget Sound. The mainstem Snoqualmie, Patterson Creek, Raging River, lower portions of the Pilchuck River, mainstem Skykomish, mainstem Snohomish, and Estuary Drainages planning units all contain significant areas ranked highest for degradation to discharge processes.

## Sediment Process Degradation for WRIA 7

Across WRIA 7, the highest ranked AUs for degradation to sediment processes generally occur along the mainstem Snohomish, mainstem Skykomish and mainstem Snoqualmie planning units (see Figure 19). In the lowlands this is likely due to development and agricultural land uses, and in mountainous tributary AUs, it's likely associated with forestry uses.  All three basins (Lower Snohomish, Skykomish, Snoqualmie) contain significant areas of moderate-high to highest relative degradation, though the Lower Snohomish may be considered slightly lower in comparison to the other two.  The Tolt River, South Fork Skykomish, North Fork Skykomish, Upper Snoqualmie, Raging River and Patterson Creek planning units contain significant areas of highest ranking AUs for degradation to sediment processes, generally related to forestry and logging practices on steeper slopes.

Table 7 below compares basin and planning unit average rank for degradation to sediment processes and Figure 20 illustrates this comparison.  Note that though the Upper North and South Forks of the Skykomish and the Upper Snoqualmie contain high ranking AUs for degraded sediment processes, average rankings for these planning units are generally due to protected lands in national forest or wilderness areas.

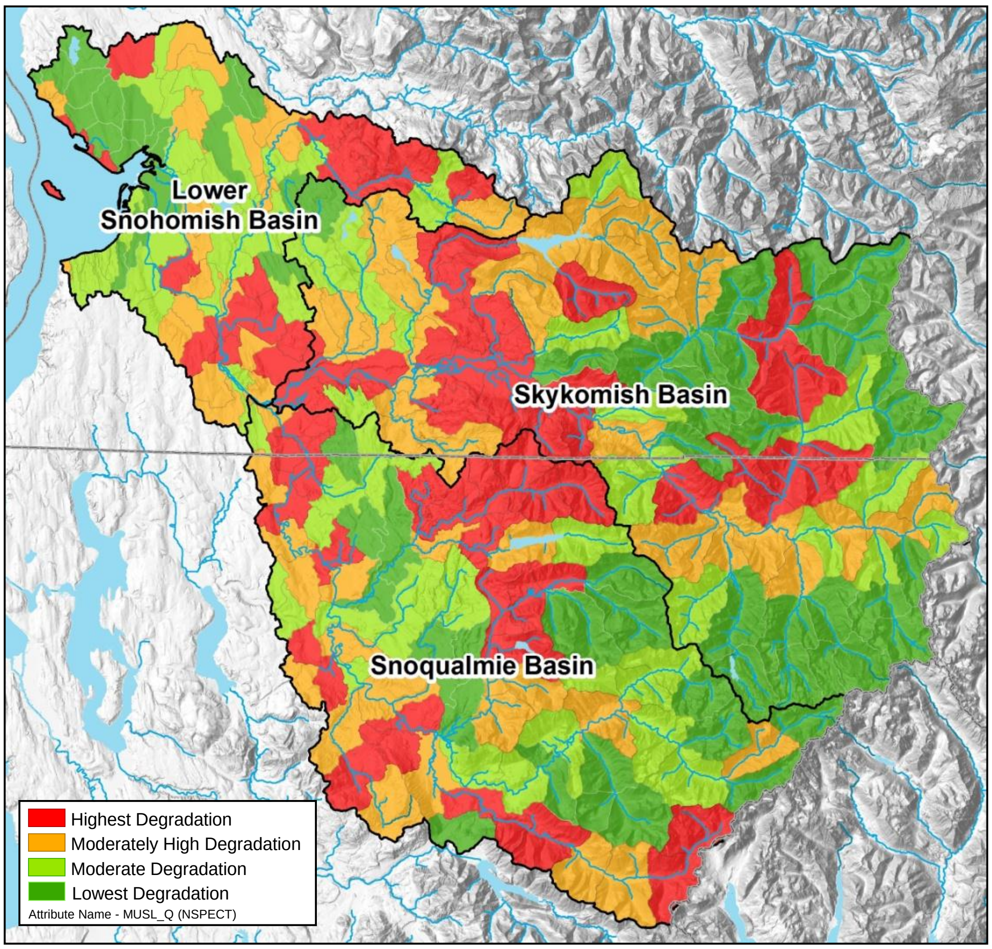



**Figure 19. Sediment process degradation results for WRIA 7.**

**Table 7. Comparison of mean assessment unit rank for degradation to sediment processes in WRIA 7, the basins and planning units.** Note, the most degraded AU received a rank of one, and the loweest value for basin average implies a higher level of degradation to sediment processes across that planning unit.

| Basin | Planning Unit | Average Rank (Sediment Degradation) | Basin Rank | WRIA Rank |
|---|---|---|---|---|
| Skykomish River Basin | Lower Mid-Skykomish River | 106 | 3 | 7 |
| | Skykomish River Mainstem | 63 | 1 | 1 |
| | Sultan River | 89 | 2 | 4 |
| | North Fork Skykomish River | 188 | 6 | 15 |
| | South Fork Skykomish River | 157 | 5 | 12 |
| | Woods Creek | 124 | 4 | 8 |
| | *basin average* | *121* | | |
| Lower Snohomish River basin | Estuary Drainages | 163 | 3 | 13 |
| | Pilchuck River | 134 | 2 | 10 |
| | Puget Sound Drainages | 181 | 4 | 14 |
| | Snohomish River Mainstem | 96 | 1 | 6 |
| | *basin average* | *143* | | |
| Snoqualmie River basin | Lowland Mid-Snoqualmie | 131 | 4 | 9 |
| | Mid-Snoqualmie River | 192 | 6 | 16 |
| | Raging River | 74 | 1 | 2 |
| | Snoqualmie River Mainstem | 96 | 3 | 5 |
| | Tolt River | 87 | 2 | 3 |
| | Upper Snoqualmie River | 141 | 5 | 11 |
| | *basin average* | *120* | | |

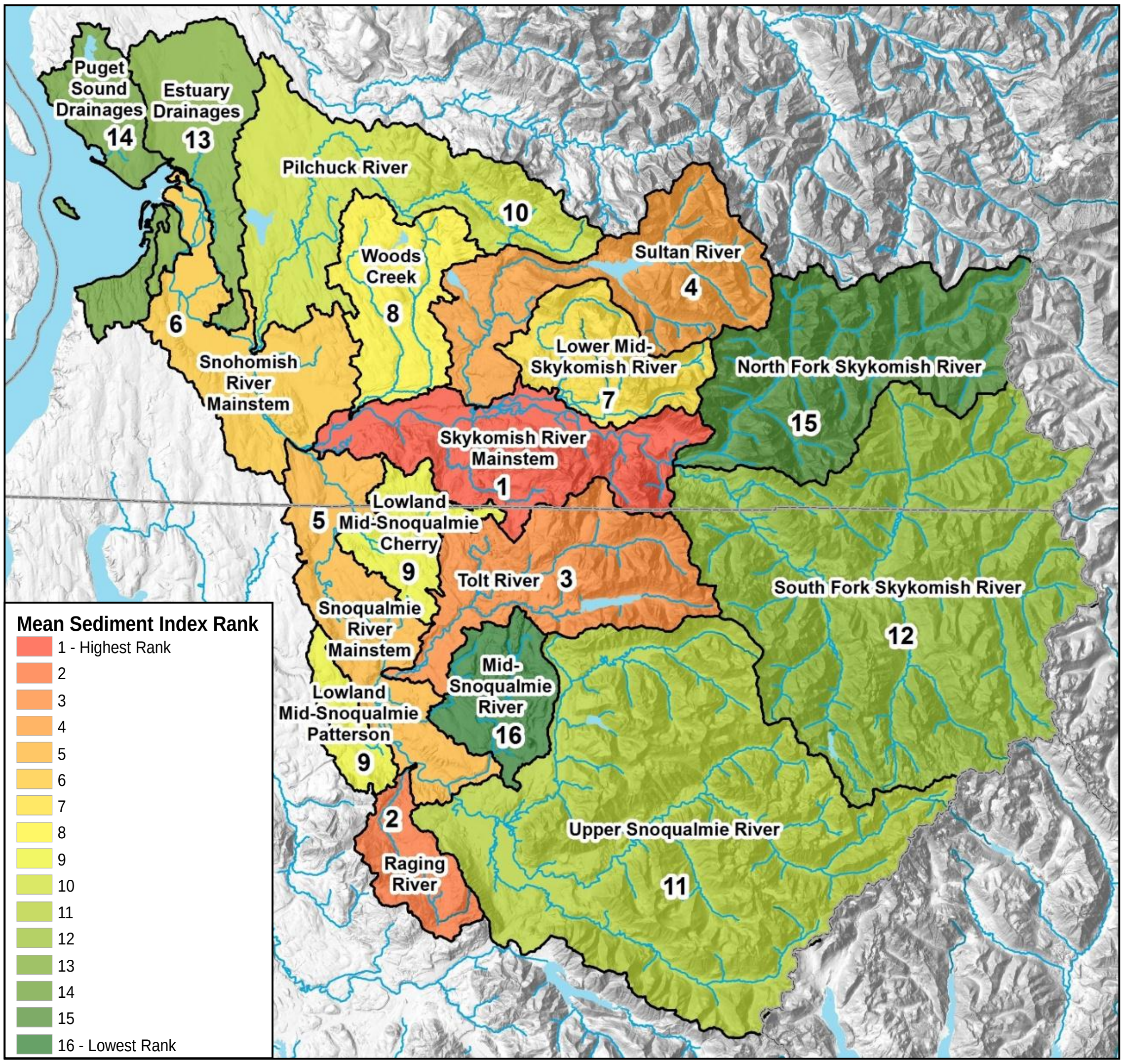



**Figure 20. Sediment process degradation rank by planning unit.**

# Salmonid Habitat Assessment for WRIA 7

The WHI (Figure 21) is a complicated index incorporating many factors (Wilhere et al. 2013), but the spatial pattern of a planning unit's mean WHI score generally reflects two main factors: salmonid species density (Figure 22) and ecological integrity (Figure 23). Salmonid species density is the sum of the stream miles occupied by each salmonid species divided by the AU area. One mile of stream occupied by three species is counted as three miles. Salmonid species density is highly correlated with, but different than, salmonid species richness (Figure 24). A comparison of the maps for ecological integrity and salmonid species density shows that they are poorly correlated. That is, high salmonid species density tends to occur in the same AUs with low ecological integrity. The aforementioned maps show that where high salmonid species density and high ecological integrity are coincident (e.g., Pilchuck River, Woods Creek, and Cherry Creek) relatively higher WHI scores result. The headwater planning units of the Lower Snohomish WRIA – North Fork Skykomish, South Fork Skykomish , and Upper Snoqualie – all have realtively high ecological integrity but have low mean WHI because of low salmonid species richness.

The salmonid habitat value, as experessed by mean AU WHI, for the Snoqualmie and Lower Snohomish basin AUs is almost equal: 0.57 and 0.56, respectively (see Table 9). Mean WHI for the Skykomish basin AUs is somewhat lower (0.45), but given the uncertainty in WHI (Wilhere et al. 2013), we should treat all three basins as having roughly equal salmonid habitat value.

All three basins have high value and low value planning units as measured by mean AU WHI . According to our Watershed Habitat Index (WHI or local salmonid habitat assessment) the Snoqualmie has the highest value planning unit, the Cherry Creek portion of the Lowland Mid-Snoqualmie planning unit; the Skykomish has the second highest value plannining unit, Woods Creek; and the Lower Snohomish has the third highest value planning unit, the Pilchuck. The relative value of these three planning units are not substantially different (Table 8), and therefore, for the purposes of WRIA-scale planning they should be treated as effectively the same value.

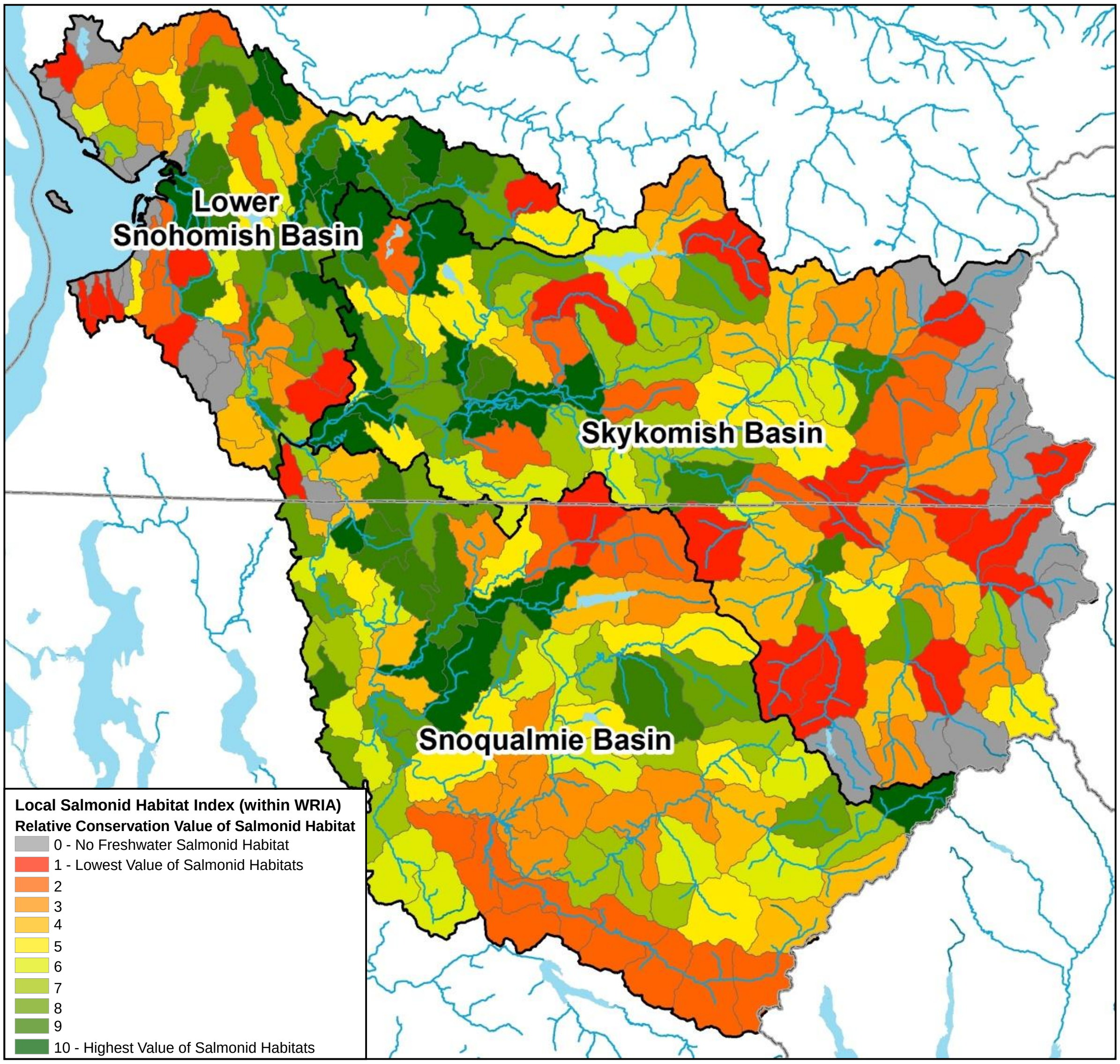



**Figure 21. Local salmonid habitat index (WHI) results for WRIA 7.**

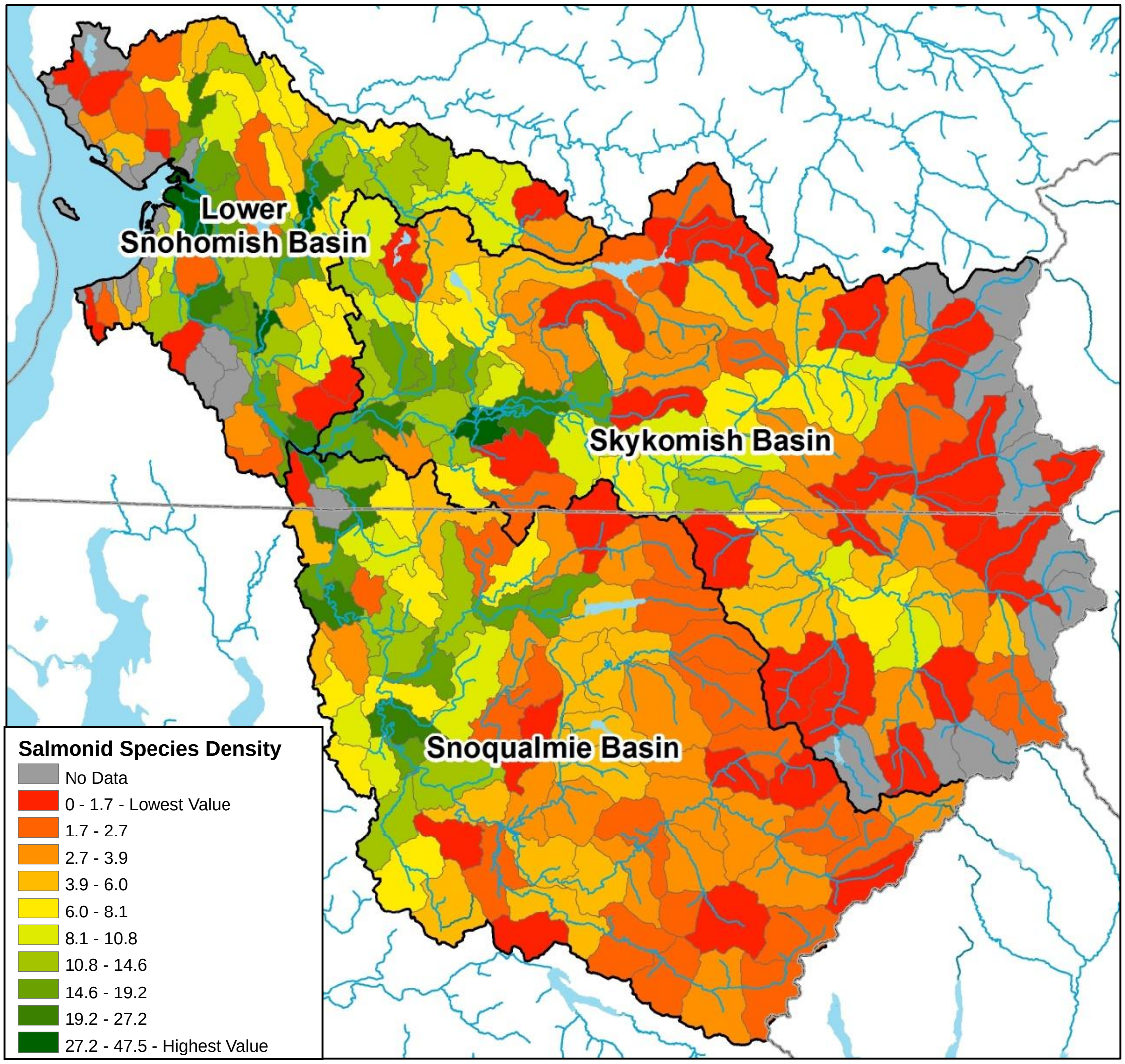



**Figure 22. Salmonid species density for WRIA 7.** Salmonid species density is the sum of the stream miles occupied by each salmonid species divided by the AU area.

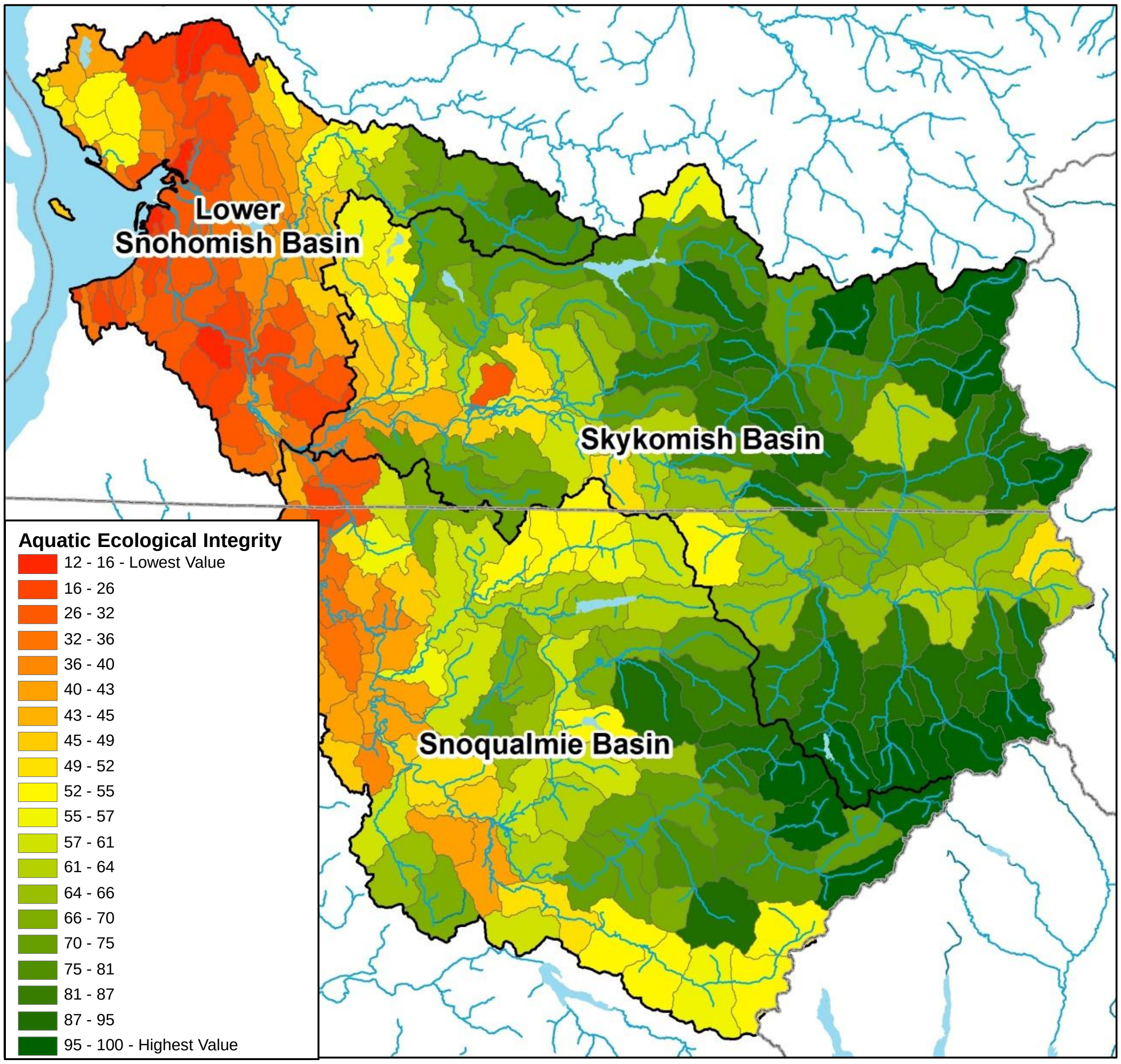



**Figure 23. Index of Aquatic Ecological Integrity for WRIA 7.**

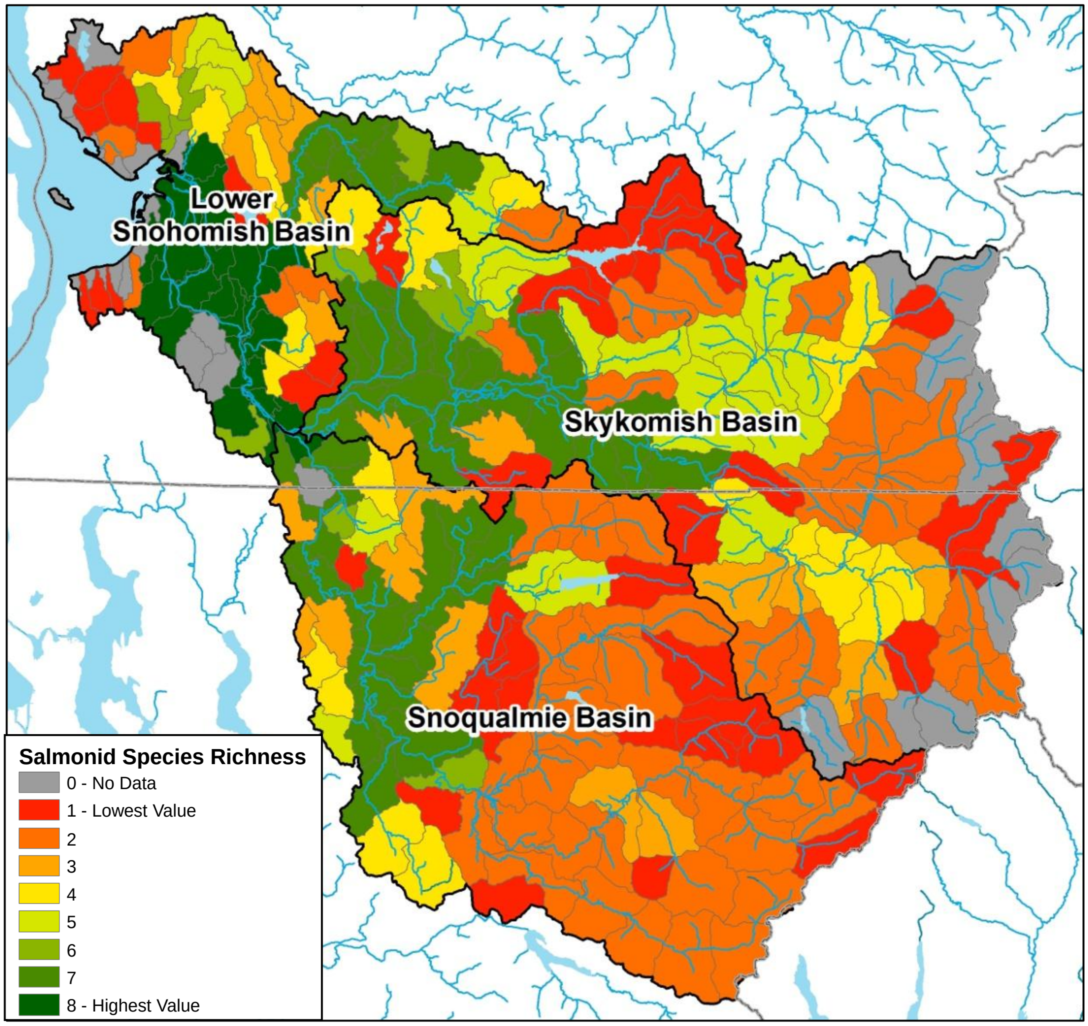



**Figure 24. Salmonid species richness for WRIA 7.** Richness is the number of salmonid species present in an AU according to our data.

Each basin also contains planning units with low mean AU WHI. The Lower Snohomish has the lowest value planning unit, the Puget Drainages, and the Skykomish has the second lowest value planning unit, the South Fork Skykomish. The relative value of these two planning units are not substantially different (Table 8), and therefore, for the purposes of WRIA-scale planning they should be treated as effectively the same value. The Snoqualmie basin's lowest value planning unit was the Tolt River.

The mean AU WHI for each planning unit obscures some important details. For instance, while the Tolt planning unit was ranked 12$^{th}$ among 16 planning units (Figure 25), it contained the highest ranked AU in the Snoqualmie basin for WHI, which was also the 5$^{th}$ highest ranked AU in the WRIA (Figure 21). This pattern is common for most planning units, i.e., AUs within planning units tend to exhibit wide-range of values for WHI.

**Table 8. Summary of freshwater habitat assessment by planning unit within basins.** Mean values are an area weighted means, where areas are those of AUs within the subbasin. Rank is planning unit rank in WRIA 7.

| Basin | Planning Unit | Number of AUs | mean WHI | Basin rank mean WHI | WRIA 7 rank mean WHI |
|---|---|---|---|---|---|
| **Snoqualmie** | Lowland Mid-Snoqualmie | 11 | 0.84 | 1 | 1 |
| | Mid-Snoqualmie | 5 | 0.70 | 2 | 5 |
| | Raging River | 3 | 0.64 | 3 | 6 |
| | Snoqualmie Mainstem | 15 | 0.60 | 4 | 8 |
| | Upper Snoqualmie | 38 | 0.57 | 5 | 10 |
| | Tolt River | 12 | 0.52 | 6 | 12 |
| **Lower Snohomish** | Pilchuck River | 26 | 0.73 | 1 | 3 |
| | Estuary Drainages | 18 | 0.51 | 2 | 9 |
| | Snohomish Mainstem | 20 | 0.44 | 3 | 13 |
| | Puget Sound Drainages | 25 | 0.18 | 4 | 16 |
| **Skykomish** | Woods Creek | 10 | 0.78 | 1 | 2 |
| | Skykomish Mainstem | 13 | 0.71 | 2 | 4 |
| | Sultan River | 12 | 0.62 | 3 | 7 |
| | Lower Mid-Skykomish | 7 | 0.58 | 4 | 11 |
| | North Fork Skykomish | 15 | 0.41 | 5 | 14 |
| | South Fork Skykomish | 38 | 0.30 | 6 | 15 |
| | **0verall** | **268** | **0.51** | | |

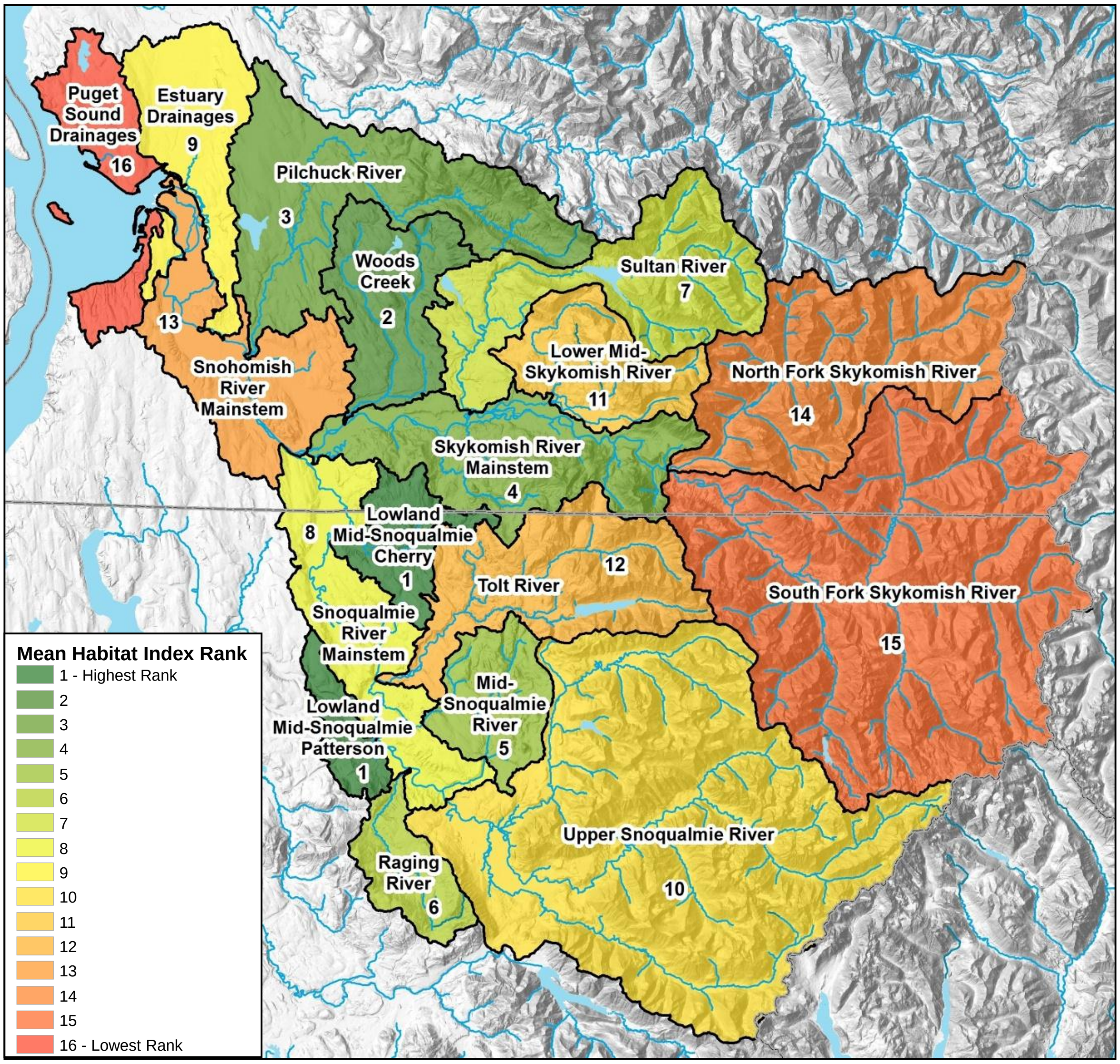



**Figure 25. Ranks of mean habitat index (WHI) for each planning unit in WRIA 7.** Green is highest rank and red is lowest rank.

# Basin Comparison of Assessments for WRIA 7

Table 9 below compares ranks for water flow processes, sediment process degradation, and local salmonid habitat across the Lower Snohomish, Snoqualmie and Skykomish basins. This comparison can be helpful in broad-scale planning for the WRIA in decisions which attempt to allocate resources across basins. The Skykomish and Snoqualmie basins are generally higher ranked for importance to overall water flow processes and contain relatively more landscape features considered important to hydrologic processes. However, they also exhibit a higher relative level of degraded sediment processes. In contrast, the Lower Snohomish basin is generally lower ranked for importance to water flow processes and degradation to sediment processes. Comparisons across basins for salmonid habitats are generally not informative at this scale.

**Table 9. Summary of basin comparisons for water flow, sediment processes, and salmonid habitats.** WHI signifies watershed habitat index results. AU = assessment unit

| **Scale 2 Basin** | Water Flow Processes Importance | Water flow Processes Degradation | Sediment process Degradation | Salmonid Habitats |
|---|---|---|---|---|
| Lower Snohomish | **Overall water flow**: basin with the lowest average AU rank<br><br>**Contains highest ranked AUs for:** surface storage and discharge processes | **Overall water flow**: highest ranked basin for degradation<br><br>**Contains highest ranked (most degraded) AUs for:** delivery, surface storage, recharge and discharge processes | Lowest ranked for degradation to sediment processes | **Mean WHI values are not substantially different among basins. Ranks are not informative.**<br><br>Mean WHI = 0.56<br>rank WHI = 2 |
| Skykomish | **Overall water flow**: basin with the highest average AU rank<br><br>**Contains highest ranked AUs for:** delivery and recharge processes | **Overall water flow**: lowest ranked basin for degradation<br><br>**Contains highest ranked (most degraded) AUs for:** surface storage and recharge processes | Generally tied with Snoqualmie for highest sediment process degradation | Mean WHI = 0.45<br>rank WHI = 3 |
| Snoqualmie | **Overall water flow**: basin with the second highest average AU rank<br><br>**Contains highest ranked AUs for**: delivery and recharge processes | **Overall water flow**: second ranked basin for degradation<br><br>**Contains highest ranked (most degraded) AUs for:** surface storage , recharge and discharge processes. | Generally tied with Skykomish for highest sediment process degradation | Mean WHI = 0.57<br>rank WHI = 1 |

# Scale 2 Basin Summaries

## Lower Snohomish Basin

The Lower Snohomish basin is comprised of freshwater systems draining from the Snoqualmie and Skykomish Rivers which form the mainstem Snohomish River, as well as the Pilchuck River, and Estuary Drainages of Quilceda and Allen Creeks (Figure 26). Additionally, this basin is composed of the Puget Sound nearshore drainages which flow directly into the Posession Sound. The results for water flow, sediment process degradation, and salmonid habitats are described as follows and also summarized in an integration table (Table 13).

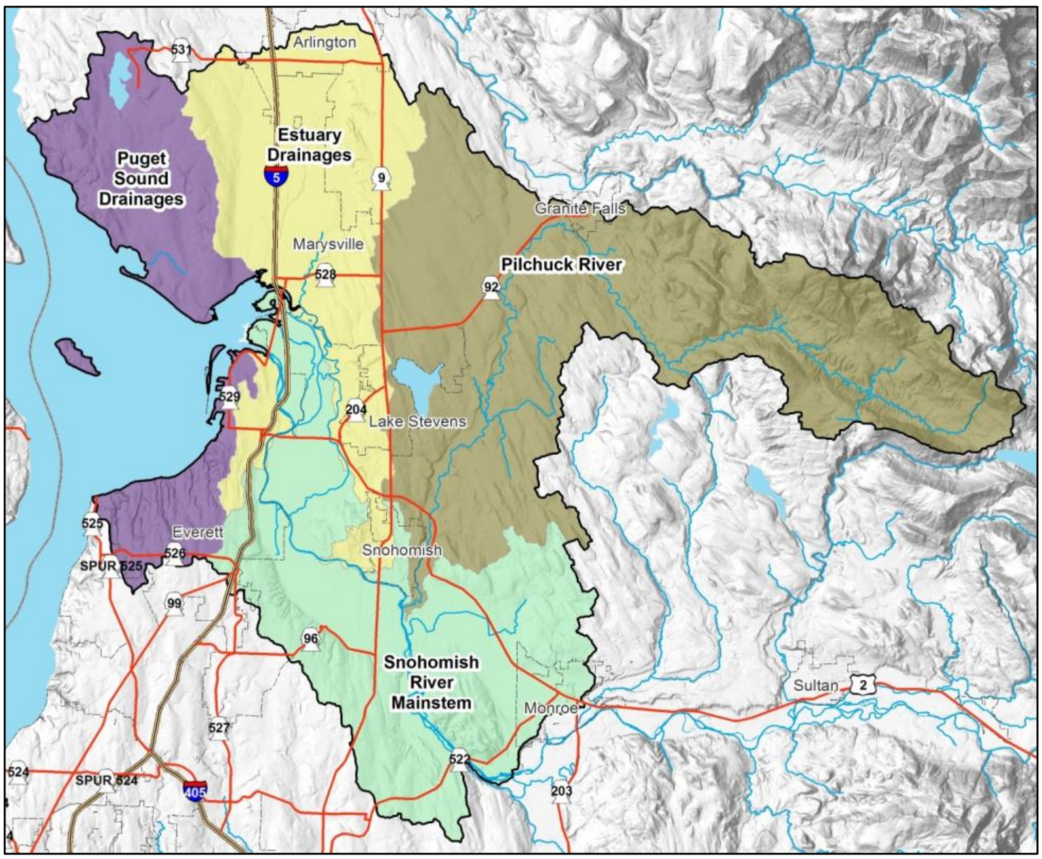



**Figure 26. Planning units of the Lower Snohomish basin.**

### Water Flow Process Assessment Results for the Lower Snohomish Basin

The following is a description of the scale 2 water flow assessment for the Lower Snohomish basin. Results for the water flow assessment at this scale compares AUs only within the Lower Snohomish basin. AU rankings presented at this scale are not directly comparable to results at other scales or between the two other basins.

**Overall Water Flow**

Across the Lower Snohomish basin, the highest ranked AUs for importance to overall water flow processes can be found throughout the Pilchuck River and Snohomish River Mainstem planning units, though the Estuary Drainages also contain some moderate-high to high ranked AUs (see Figure 27). Table 10 below compares average overall importance rankings for the planning units across the Lower Snohomish basin. The Snohomish mainstem is ranked first followed by the Pilchuck River for overall importance.

Highest ranked AUs for degradation to overall water flow processes are generally found in the Estuary Drainages and Southern Puget Sound drainages planning units, though some significant moderate-high to high ranked AUs are found in the Snohomish mainstem and lower Pilchuck river as well (Figure 27). The Estuary Drainages ranks highest for overall degradation across the basin with the Snohomish mainstem ranked second.

**Table 10. Average assessment unit (AU) rank for overall water flow processes for planning units of the Lower Snohomish basin.**

| | | | Overall Importance to water flow | | | Overall Degradation to Water Flow | | |
|---|---|---|---|---|---|---|---|---|
| Basin | Planning Unit | # of AUs | Average AU Rank WF_M1 | Basin Rank | WRIA Rank | Average AU Rank WF_M2 | Basin Rank | WRIA Rank |
| Snohomish River basin | Estuary Drainages | 18 | 193 | 3 | 14 | 31 | 1 | 1 |
| | Pilchuck River | 26 | 175 | 2 | 10 | 100 | 4 | 5 |
| | Puget Sound Drainages | 25 | 243 | 4 | 16 | 67 | 3 | 3 |
| | Snohomish River Mainstem | 19 | 137 | 1 | 7 | 45 | 2 | 2 |
| | *basin* | *88* | *187* | | | *61* | | |

**Delivery**

Across the basin, highest ranked AUs for importance to delivery are found in the upper watershed of the Pilchuck and the AUs at the eastern end of the Snohomish mainstem due to higher relative precipitation in these areas. The Pilchuck River planning unit generally ranks highest for Importace to delivery, while the Puget Sound Drainages rank lowest. Highest ranked AUs for degradation to delivery processes are generally found in the Puget Sound and Estuary Drainages as well as the lower Snohomish mainstem. This is primarily due to increased impervious surface and forest loss in these AUs.

**Surface Storage**

Across the Lower Snohomish basin the highest ranked AUs for importance to surface storage processes are primarily found in the Snohomish mainstem and Estuary Drainages planning units, with some moderate-high to high ranked AUs in the lower watershed of the Pilchuck as well. This is primarily due to higher relative proportion of wetlands, lakes and unconfined floodplain areas in these AUs. Generally the Snohomish mainstem ranks highest in the basin for importance to storage processes.

Highest ranked AUs for degradation to surface storage processes are generally found in the Snohomish mainstem and Estuary Drainages planning units due to greater loss of historic wetlands and greater channelization and disconnection of streams from floodplains. The

Snohomish mainstem ranks as the most degraded of the planning units for surface storage processes.

**Recharge**

Across the Lower Snohomish basin the highest ranked AUs for importance to recharge processes are generally found in the upper watershed of the Pilchuck River, the eastern AUs of the Snohomish mainstem, and the AUs along Quiliceda Creek in the Estuary Drainages planning unit. These rankings are due to higher relative precipitation and areas of higher permeable surface deposits. The Pilchuck River planning unit ranks highest for importance to recharge processes.

Highest ranked AUs for degradation to recharge processes are primarily found in the southern Puget Sound Drainages, the AUs along Quilceda Creek in the Estuary Drainages, and some parts of the Snohomish mainstem planning unit. This is due to relatively higher amounts of impervious surface and higher intensity development on permeable surficial deposits in these AUs. The Estuary Drainages and Puget Sound Drainages planning units rank highest for degradation to recharge processes.

**Discharge**

Across the Lower Snohomish basin AUs ranked highest for importance to discharge processes are generally found in the Pilchuck River along the mainstem, Allen Creek in the Estuary Drainages, and throughout the Snohomish mainstem planning units due to the presence of slope wetlands and floodplains intersecting permeable surficial deposits. There is no clear highest ranked planning unit for importance to discharge, though the Puget Sound Drainages generally is covered by lower ranked AUs.

AUs ranked highest for degradation to discharge are found in the Estuary Drainages around Quilceda and Allen creeks, throughout the Snomish mainstem, and along the lower Pilchuck river. Some of the AUs lining Tulalip Bay in the Puget Sound drainages are also highest ranked for degradation to discharge processes. This is due to greater development within or adjacent to slope wetlands and floodplains with high permeability, higher density of roads and ditches, and groundwater wells which impact those processes.

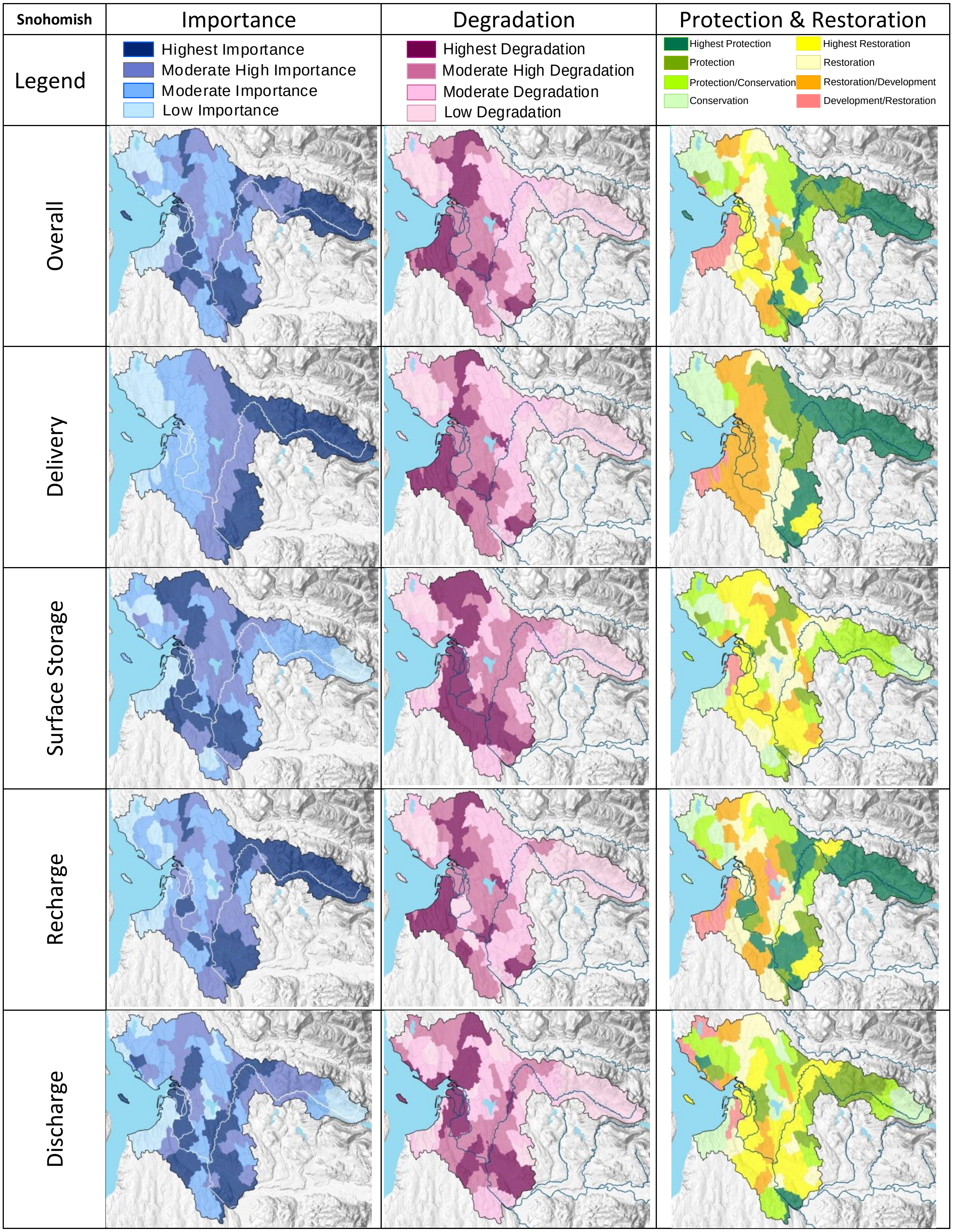



**Figure 27. Scale 2 water flow assessment results for the Lower Snohomish basin.**

## Sediment Process Degradation Assessment Results for the Lower Snohomish Basin

Across the Lower Snohomish basin, the Snohomish mainstem planning unit ranks generally highest for degradation to sediment processes, followed by the Pilchuck River and Estuary Drainages planning units (Figure 28 & Table 11). Given the structure of the sediment process degradation model, it is helpful to understand the land use and landscape context of an AU to determine the likely cause behind relatively higher levels of degradation.

The Lower Snohomish basin has three general categories of degraded sediment processes:

- Mountainous areas with steep slopes, high precipitation, erodible soils and intense forestry activities;
- lowland floodplain areas with erodible soils, moderate precipitation and intense agricultural activities and/or urban development;
- lowland coastal areas with erodible soils, moderate slopes, moderate precipitation and urban development.

For the mountainous areas, the model results suggests that the Pilchuck River planning unit has relatively high rates of sediment export due to commercial logging activities in the upper watershed. For the lowland floodplain category, results suggest higher levels of sediment export due to commercial agricultural activities and urban development in the Snohomish mainstem and lower Pilchuck river. For the lowland coastal category, the model suggests that the urban and adjoining rural residential areas in the Puget Sound Drainages planning unit around Tulalip Bay have high rates of sediment export.

**Table 11. Average assessment unit (AU) rank for sediment degradation for planning units of the Lower Snohomish basin.** Note, results are at the WRIA scale, where the most degraded AU received a rank of one. Therefore a lower numerical value for average rank implies a higher level of average degradation.

| | | Average Rank (Sediment Degradation) | Basin Rank | WRIA Rank |
|---|---|---|---|---|
| Snohomish River basin | Estuary Drainages | 163 | 3 | 13 |
| | Pilchuck River | 134 | 2 | 10 |
| | Puget Sound Drainages | 181 | 4 | 14 |
| | Snohomish River Mainstem | 96 | 1 | 6 |
| | *basin average* | *143* | | |

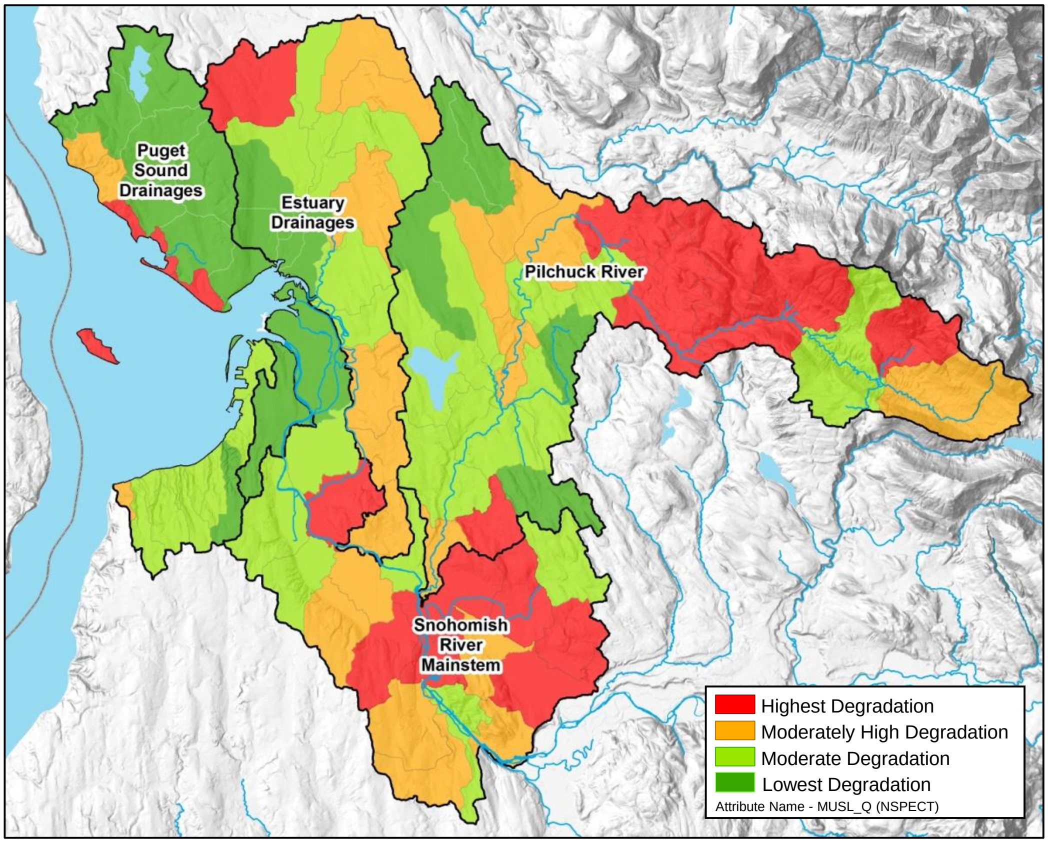



**Figure 28. Scale 1 sediment process degradation results for the Lower Snohomish basin from WRIA scale assessment.**

## Salmonid Habitat Assessment Results for the Lower Snohomish Basin

According to our assessment the highest value salmonid habitats are in the Pilchuck planning unit (Figure 29 & Table 12). Nine of the top ten AU-scale WHI scores in the basin are in the Pilchuck, and one of these AUs was tied for the highest ranked AU in the planning unit, basin, and WRIA. The high WHI scores are mainly due to high salmonid species richness and high ecological integrity. The lowest value planning unit for salmonid habitats in the basin and also the WRIA is the Puget Drainages. The highest ranked AU in the Puget Sound Drainages was 30 out of the 89 AUs in the basin. The Lower Snohomish basin contains 20 AUs with WHI equal to zero because according to our data they are not inhabitated by any salmonid species; 16 of those AUs are in the Puget Sound Drainages planning unit.

The WHI model does not incorporate the important habitat functions of esturaries or the potential value of restored habitats. Therefore, the Estuary Drainages, Puget Sound Drainages and Snohomish mainstem planning units are probably undervalued by our assessment. However, at the AU-scale, AUs at the mouth of the Snohomish River did obtain relatively high scores for WHI. In fact, one AU at the mouth was tied for the highest ranked AU in the planning unit, basin, and WRIA.

**Table 12. Mean rank for the local salmonid habitat assessment (WHI) for planning units of the Lower Snohomish basin.**

| Basin | Planning unit | Number of AUs | mean WHI | Basin rank mean WHI | WRIA 7 rank mean WHI |
|---|---|---|---|---|---|
| Lower Snohomish | Pilchuck River | 26 | 0.73 | 1 | 3 |
| | Estuary Drainages | 18 | 0.51 | 2 | 9 |
| | Snohomish Mainstem | 19 | 0.44 | 3 | 13 |
| | Puget Sound Drainages | 25 | 0.18 | 4 | 16 |

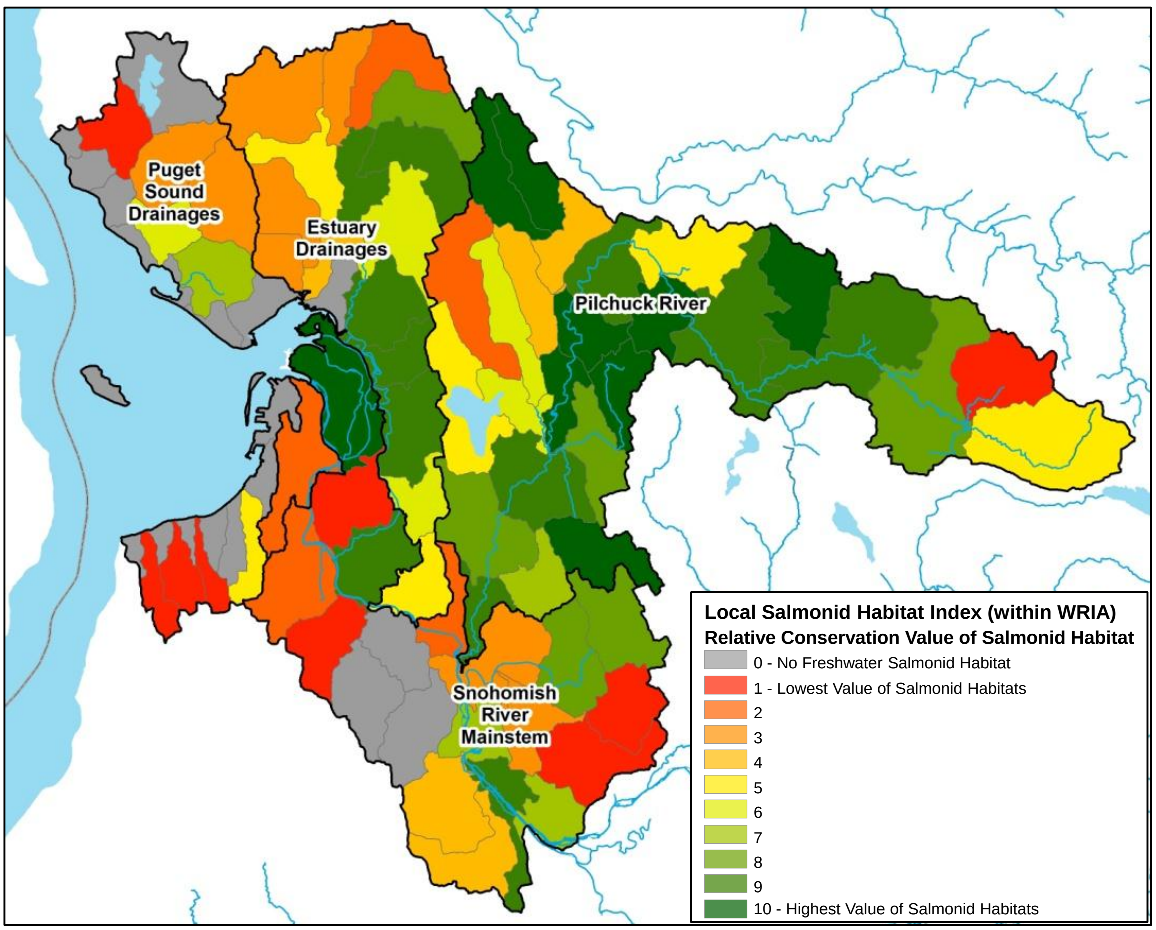



**Figure 29. Local salmonid habitat index (WHI) for each AU in the Lower Snohomish basin.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

## Planning Unit Comparison across Assessments for the Lower Snohomish Basin

Table 13 below summarizes the assessment results for the Lower Snohomish basin. Recall that the water flow results presented below are those from the scale 2 assessment, including the management considerations. Comparisons of planning unit ranks utilize the scale 1 results across all three categories of assessment (water flow, sediment, salmonid habitats).

Following is a brief description of the Pilchuck River planning unit which appears to provide particularly good protection and restoration opportunities in the basin.

The Pilchuck River planning unit is both highly ranked and least degraded for water flow processes in the basin. Additionally, the Pilchuck ranks highest for salmonid habitats and may provide excellent multi-benefit protection and restoration opportunities. However, sediment process degradation is relatively high in a number of the Pilchuck headwaters AUs so strategies, particularly those attempting to address instream habitats downstream of those degraded AUs, should account for this in their design and implementation.

**Table 13. Planning unit (PU) comparison across assessments of the Lower Snohomish basin.**

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Puget Sound Drainages** | **Overall water flow**: Generally contains lowest to moderate ranked AUs.<br><br>Ranks 4th out of 4 PUs in the Lower Snohomish basin, 16th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: discharge | **Overall water flow**: Contains highest ranked AUs in the drainages south of the Snohomish estuary.<br><br>Ranks as 3rd most degraded out of 4 PUs in the Lower Snohomish basin, 3rd most degraded out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for:** recharge, discharge, delivery | Ranks 4th most degraded out of 4 PUs in the basin, 14th out of 16 in WRIA for degration to sediment | Ranks 4th in the basin and 16th out of 16 planning units in WRIA 7 for local salmonid habitat value (mean WHI). | <u>**Water flow:**</u><br>**Overall land use recommendation**: Protection & Conservation in northern AUs, Lowest Restoration & Development in southern drainages<br><br>**Priority water flow processes to protect and restore**: Protection of surface storage, recharge and discharge in northern drainages around Tulalip creek. |

Table 13 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Estuary Drainages** (Quilceda /Allen creeks) | **Overall water flow**: Highest ranked AUs located in the upper portions of Quilceda creek.<br><br>Ranks 3rd out of 4 PUs in the basin, 14th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, recharge, discharge | **Overall water flow**: Highest ranked AUs located in the upper portions of Quilceda, Allen creeks.<br><br>Ranks as most degraded (out of 4 PUs) in the Lower Snohomish basin and the WRIA (out of 16) .<br><br>**Contains highest ranked AUs for:** delivery, discharge, surface storage | Ranks 3rd out of 4 PUs for degration to sediment in the basin.<br><br>Ranks 13th out of 16 PUs in the WRIA. | Ranks 2nd out of 4 PUs in the basin and 9th out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | **Water flow:**<br>**Overall land use recommendation:** Restoration<br><br>**Priority water flow processes to protect and restore**: Restoration of surface storage, recharge, and discharge |

Table 13 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Pilchuck River** | **Overall water flow**: Highest ranked and moderate-high ranked AUs throughout the upper and lower watershed.<br>Ranks 2nd in the basin out of 4 PUs, 10th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, recharge, discharge, delivery. | **Overall water flow**: Generally lowest ranked for overall degradation but some areas in the lower watershed rank moderate-high to high.<br>Ranks as least degraded out of 4 PUs in the Lower Snohomish basin, 5th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for:** surface storage and discharge in the lower watershed. | Ranked as 2nd out of 4 PUs for degradation to sediment in the Lower Snohomish basin, 10th out of 16 in the WRIA. | Ranks 1st out of 4 PUs in the basin and 3rd highest out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | **<u>Water flow:</u>**<br>**Overall land use recommendation**: Highest Protection in the upper watershed, Protection & Restoration in the lower watershed<br><br>**Priority water flow components to protect and restore**: Protection of recharge and delivery in the upper watershed, restoration of discharge and surface storage in the lower watershed |

Table 13 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Mainstem Snohomish** | **Overall water flow**: Highest ranked AUs located throughout the lower Snohomish mainstem and French Creek area.<br><br>Ranks 1st out of 4 PUs in the Lower Snohomish basin, 7th out of 16 in the WRIA. **Contains highest ranked subcomponents for**: surface storage, recharge, discharge, | **Overall water flow**: Moderate-high ranked AUs for degradation located throughout the planning unit.<br><br>Ranks as 2nd most degraded out of 4 PUs in the Lower Snohomish basin, 2nd out of 16 in the WRIA. **Contains highest ranked AUs for:** surface storage, recharge, discharge, delivery | Ranked as most degraded out of 4 PUs for degradation to sediment in the basin, and 6th out of 16 in the WRIA. | Ranks 3rd out of 4 PUs in the basin and 13th out of 16 in the WRIA for local salmonid habitat value (mean WHI). | **<u>Water flow:</u>**<br>**Overall land use recommendation**: Restoration<br><br>**Priority water flow processes to protect and restore**: Restoration of surface storage, discharge, protection & restoration of recharge processes |

# Snoqualmie Basin

The Snoqualmie basin is comprised of freshwater systems extending from the crest of the Cascades at Snoqualmie Pass, west and northward to its confluence with the Skykomish and the Lower Snohomish basins (Figure 30). The basin consists of three major forks of the Snoqualmie River in addition to major tributaries to the mainstem of the Snoqualmie, including the Tokul and Tolt Rivers, and Griffin and Cherry Creek. The results for water flow, water quality (sediment) and local salmonid habitat are summarized below.

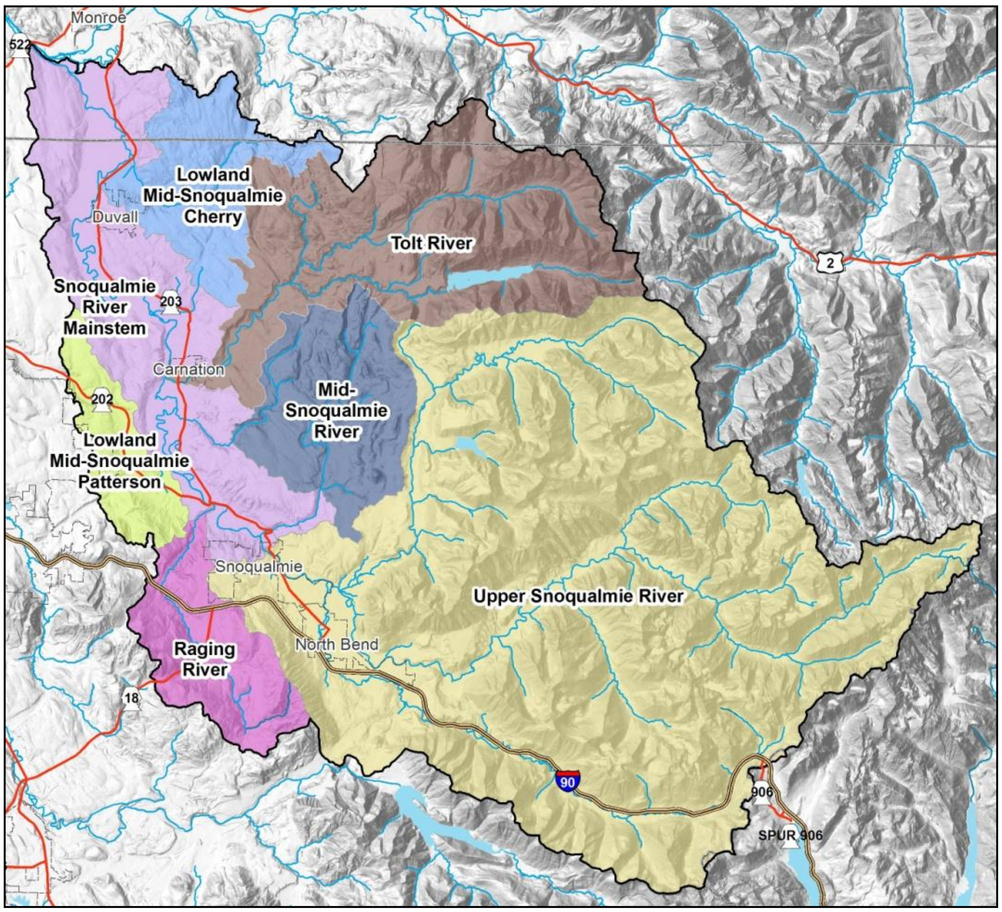



**Figure 30. Planning units of the Snoqualmie basin.**

## Water Flow Process Assessment Results for the Snoqualmie Basin

The following is a description of the scale 2 water flow assessment for the Snoqualmie basin. Results for the water flow assessment at this scale do not use landscape groups and AUs are compared only within the Snoqualmie basin. AU rankings presented at this scale are not directly comparable to results at other scales or between the two other basins.

### Overall Water Flow Processes

Across the Snoqualmie basin, the highest ranked AUs for importance to overall water flow processes are primarily located in the Upper Snoqualmie planning unit (Figure 31), though some areas of highest and moderate-high ranked AUs can be found in the North and South Forks of the Tolt River, as well as the lower, mainstem Snoqualmie. The Upper Snoqualmie ranks highest for overall importance, followed by the Tolt River and the Raging River planning units (Table 14) based on average AU rank.

AUs ranked highest for overall degradation to water flow processes are generally located in the mainstem Snoqualmie, Patterson creek, and lower watershed of the Upper Snoqualmie planning unit. The mainstem Snoqualmie ranks highest for degradation to overall water flow processes, followed by Patterson and Cherry Creeks (Lowland Mid-Snoqualmie planning unit) based on average AU rank.

**Table 14. Average assessment unit (AU) rank for overall water flow processes for planning units of the Snoqualmie basin.**

| | | | Overall Importance to water flow | | | Overall Degradation to Water Flow | | |
|---|---|---|---|---|---|---|---|---|
| Basin | Planning Unit | # of AUs | Average AU Rank WF_M1 | Basin Rank | WRIA Rank | Average AU Rank WF_M2 | Basin Rank | WRIA Rank |
| Snoqualmie River basin | Lowland Mid-Snoqualmie | 11 | 192 | 6 | 13 | 103 | 2 | 6 |
| | Mid-Snoqualmie River | 5 | 181 | 4 | 11 | 165 | 5 | 11 |
| | Raging River | 3 | 165 | 3 | 9 | 139 | 3 | 9 |
| | Snoqualmie River Mainstem | 15 | 182 | 5 | 12 | 85 | 1 | 4 |
| | Tolt River | 12 | 128 | 2 | 5 | 156 | 4 | 10 |
| | Upper Snoqualmie River | 38 | 63 | 1 | 3 | 184 | 6 | 14 |
| | *basin* | *84* | *152* | | | *139* | | |

### Delivery
Across the Snoqualmie basin the highest ranked AUs for importance to delivery processes are found in the upper watershed tributaries of the Upper Snoqualmie, the North and South Forks of the Tolt River, and the upper watershed of the Raging River. The Upper Snoqualmie planning unit is generally ranked highest for importance to delivery, followed by the Tolt River and Raging River. This is due to the higher relative levels of precipitation and rain-on-snow areas in these AUs.

The highest ranked AUs for degradation to delivery processes are generally located in the Mainstem Snoqualmie planning unit, Patterson and Cherry Creeks, and the lower watershed of the Upper Snoqualmie planning unit. This is generally due to increased impervious surface and forest loss in these AUs. Generally, the highest ranked planning unit for degradation to delivery in the Snoqualmie basin is the Mainstem Snoqualmie, followed by Patterson Creek.

### Surface Storage
AUs ranked highest for importance to surface storage process are located in the Mainstem Snoqualmie planning unit, Patterson and Cherry Creeks, and the Middle Fork of the Upper Snoqualmie planning unit due to a higher relative proportion of wetlands, lakes and unconfined floodplains in these AUs. The Mainstem Snoqualmie planning unit generally ranks highest, followed by Patterson and Cherry Creeks for importance to surface storage processes.

AUs ranked highest for degradation to surface storage processes in the Snoqualmie basin are generally located in the Snoqualmie Mainstem planning unit, Patterson and Cherry Creeks, and the lower watershed of the Upper Snoqualmie planning unit. The Snoqualmie mainstem generally ranks highest for degradation to surface storage due to greater loss of historic wetlands and greater channelization and disconnection of streams and rivers from floodplains.

**Recharge**
AUs ranked highest for importance to recharge across the Snoqualmie basin are located in the Upper Snoqualmie and the Tolt River planning unit due to the higher relative precipitation and areas of higher permeability surficial deposits. The Upper Snoqualmie generally ranks highest, with the Tolt ranked second, followed by the Raging River and Snoqualmie mainstem planning unit.

AUs ranked highest for degradation to recharge are generally located in the Mainstem Snoqualmie planning unit, Patterson and Cherry Creeks, and the South Fork of the Upper Snoqualmie due to impervious surface and higher intensity development on permeable surficial deposits. Generally, the Mainstem Snoqualmie and Patterson Creek rank highest for degradation to recharge, followed by the Upper Snoqualmie and Cherry creek planning units. For the Upper Snoqualamie and Cherry Creek planning units, the majority of impacts to recharge processes are located within or adjacent to urban areas within the lower reaches of these units (e.g. Duvall, Snoqualamie, North Bend).

**Discharge**
Highest ranked AUs for importance to discharge across the Snoqualmie basin are located in the mainstem Snoqualmie planning unit, Cherry and Patterson Creeks, The Middle Fork of the Upper Snoqualmie, and the Mid-Snoqualmie planning units due to the presence of slope wetlands and floodplains intersecting permeable deposits. The Mainstem Snoqualmie generally ranks highest for discharge processes, followed by Cherry/Patterson Creeks and the Mid-Snoqualmie planning units. The Upper Snoqualmie planning unit ranks generally very high, but also has significant areas of lower importance AUs relative to the rest of the Snoqualmie basin.

Highest ranked AUs for degradation to discharge processes are located in the Mainstem Snoqualmie, Patterson and Cherry Creeks, lower Raging River and lower reaches of the Upper Snoqualmie planning units due to greater development within or adjacent to slope wetlands and floodplains with high permeability deposits , higher density of roads and ditches, and groundwater wells which impact those processes. The mainstem Snoqualmie and Lower Mid-Snoqualmie rank highest for degradation to discharge processes, followed by the Raging River and Upper Snoqualmie planning units.

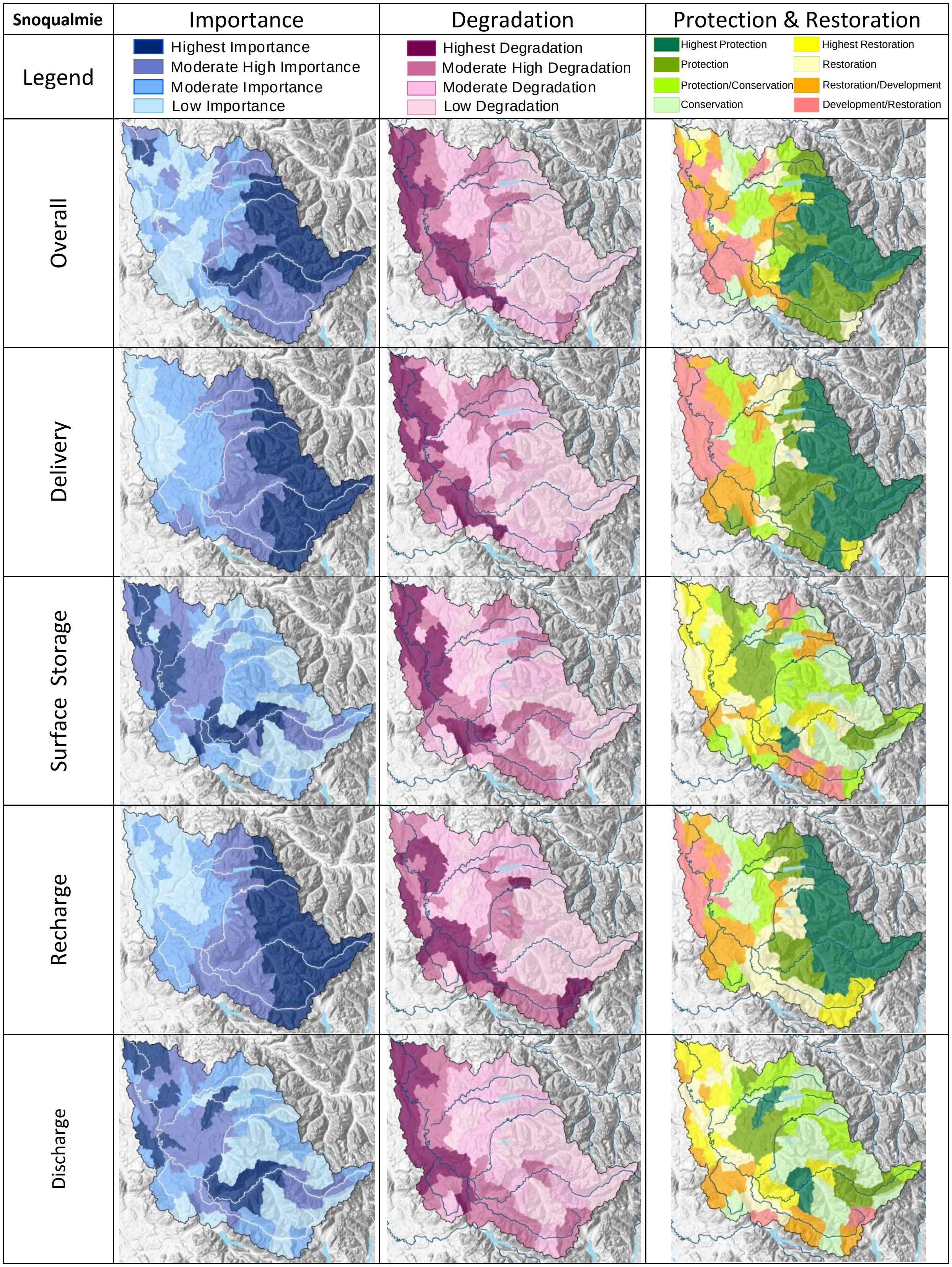



**Figure 31. Scale 2 water flow assessment results for Snoqualmie basin.**

## Sediment Process Degradation Assessment Results for the Snoqualmie Basin

Across the Snoqualmie basin, the Raging River planning unit ranks generally highest for degradation to sediment processes (Figure 32), followed by the Tolt River and Snoqualmie River mainstem planning units (Table 15). Given the structure of the sediment degradation model, it is helpful to understand the land use and landscape context of an AU to determine the likely cause behind relatively higher levels of degradation.

**Table 15. Average assessment unit (AU) rank for sediment degradation for planning units of the Snoqualmie Basin.** Note, results are at the WRIA scale, where the most degraded AU received a rank of one. Therefore a lower numerical value for average rank implies a higher level of average.

| | | Average Rank (Sediment Degradation) | Basin Rank | WRIA Rank |
|---|---|---|---|---|
| Snoqualmie River basin | Lowland Mid-Snoqualmie | 131 | 4 | 9 |
| | Mid-Snoqualmie River | 192 | 6 | 16 |
| | Raging River | 74 | 1 | 2 |
| | Snoqualmie River Mainstem | 96 | 3 | 5 |
| | Tolt River | 87 | 2 | 3 |
| | Upper Snoqualmie River | 141 | 5 | 11 |
| | *basin average* | *120* | | |

The Snoqualmie basin has three general categories of degraded sediment processes:

- Mountainous areas with steep slopes, high precipitation, erodible soils and intense forestry activities;
- Lowland floodplain areas, with erodible soils, moderate to high precipitation with extensive flooding and intense agricultural activities;
- Lowland floodplain areas with erodible soils, moderate to high precipitation and urban development.

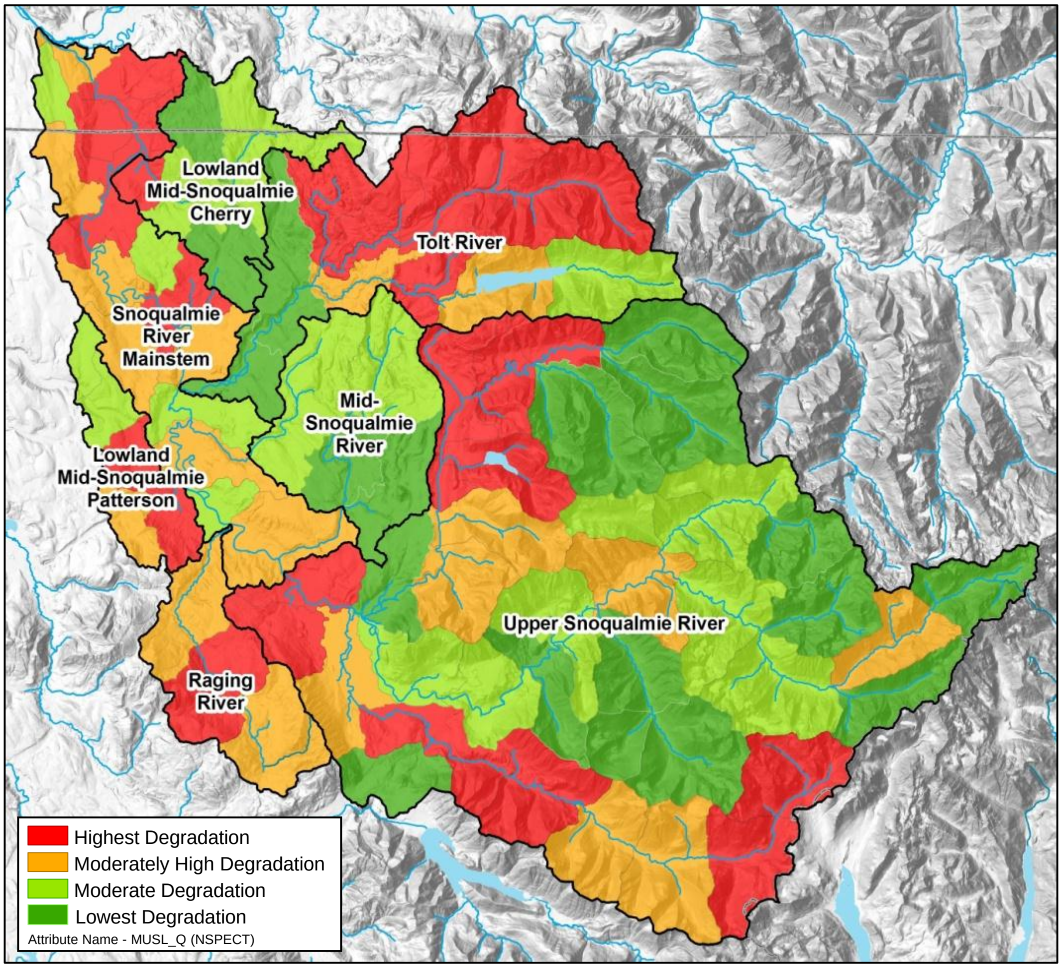



**Figure 32. Scale 1 sediment process degradation results for the Snoqualmie basin.**

For the mountainous category, the model results suggest that both the north fork of the Tolt River and Upper Snoqualmie have relatively high rates of sediment export due to logging activities. The model also indicates that the headwaters of both the mid and south fork of the Upper Snoqualmie planning unit show high relative levels of sediment process degradation which may be due to forest roads.

For the lowland floodplain category stretching from Fall City to Duvall, the model results suggest high level of sediment export due to commercial agricultural activities. For the lowland floodplain category with urban development, the model suggests that the urban and adjoining rural residential areas of North Bend and Fall City, have high rates of sediment export.

## Salmonid Habitat Results for the Snoqualmie Basin

According to our assessment the highest value planning unit for salmonid habitats is the Lowland Mid-Snoqualmie (Table 16 & Figure 33) which consists of the Cherry and Patterson creek watersheds which is suprising because the Lowland Mid-Snoqualmie planning unit has only one AU in the Snoqualmie basin's top five AUs. The Lowland Mid-Snoqualmie is the highest value, in part, because of it's uniformity: nearly all good habitat value and no poor habitat value.

The Upper Snoqualmie planning unit has moderately low rank for WHI due to high quality salmonid habitat but no naturally occurring anadromous fish upstream of Snoqualmie Falls. In the Upper Snoqualmie, high WHI was mostly due to high quality habitat for resident salmonids. The North Fork Snoqulamie has high WHI because of very high quality habitats for resident salmonids but the South Fork has lower mean WHI because of development and high stream gradient, which affects the intrinsic potential model for rainbow trout. The Mainstem Snoqualmie has a moderate rank for mean WHI due to high salmonid species richness but lower quality salmonid habitat caused by development, including agricultural development. Raging River has a moderate rank for mean WHI due to moderate ecological integrity in the lower subbasin and moderate salmonid species richness in the upper subbasin.

A big difference in WHI exists between the lower and upper Tolt River planning unit. WHI is much higher on Tolt River maintstem and lower South Fork than on the North Fork. In fact, WHI for the AU immediately below the reservoir, which is on the south fork, is highest ranked in the Snoqualmie basin. Anadromous salmonids have not historically had access to upper south fork of the Tolt River Watershed due to a natural fish passage barrier approximately one-third mile below the South Fork Tolt Dam.

**Table 16. Mean rank for the local salmonid habitat assessment (WHI) for planning units of the Snoqualmie basin.**

| Basin | Planning unit | Number of AUs | mean WHI | Basin rank mean WHI | WRIA 7 rank mean WHI |
|---|---|---|---|---|---|
| **Snoqualmie** | Lowland Mid-Snoqualmie | 11 | 0.84 | 1 | 1 |
| | Mid-Snoqualmie | 5 | 0.71 | 2 | 5 |
| | Raging River | 3 | 0.69 | 3 | 6 |
| | Snoqualmie Mainstem | 15 | 0.60 | 4 | 8 |
| | Upper Snoqualmie | 38 | 0.53 | 5 | 10 |
| | Tolt River | 12 | 0.48 | 6 | 12 |

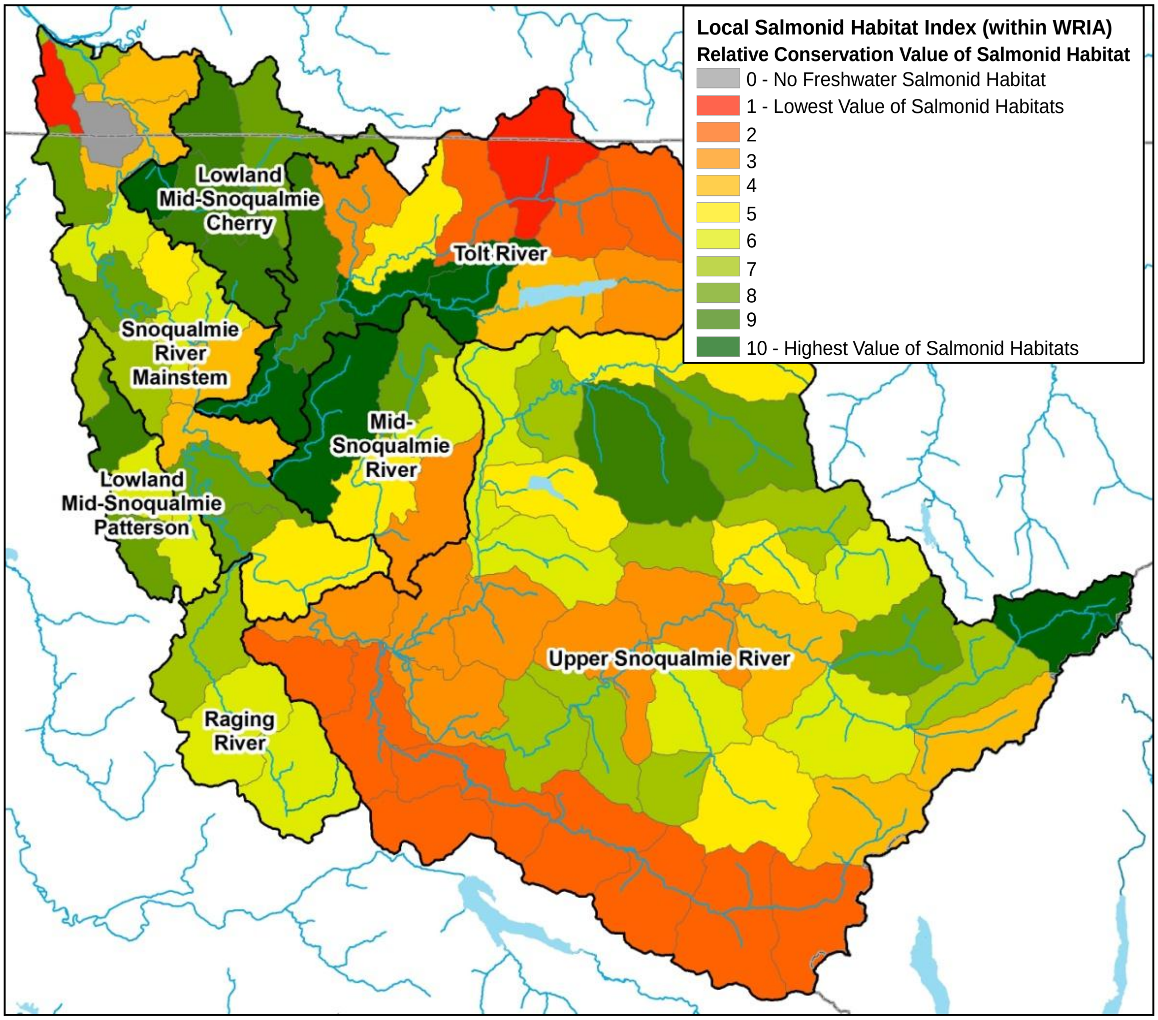



**Figure 33. Local salmonid habitat Index (WHI) for each AU in the Snoqualmie basin.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

## Planning Unit Comparison across Assessments for the Snoqualmie Basin

Table 17 below summarizes the assessment results for the Snoqualmie basin. Recall that the water flow assessment results presented below are those from the scale 2 assessment, including the management considerations. Comparisons of planning unit ranks utilize the scale 1 results across all three categories of assessment (water flow, sediment, salmonid habitats). Following is a brief description of the planning units which appear to provide particularly good protection and restoration opportunities in the basin.

The Upper Snoqualmie planning unit is the highest ranked for overall water flow processes but only 5th in the basin for salmonid habitats, though there are significant differences across the three main forks of the river with the North and Middle Forks generally ranking higher. Additionally, the planning unit is lowest ranked for both degradation to water flow and sediment processes indicating excellent opportunities for protection with relatively fewer potential limiting factors due to process degradation.

The Mid-Snoqualmie planning unit comprised of Griffin and Tokul creeks is only moderately important for water flow processes relative to the rest of the basin but is highly ranked for salmonid habitats. Additionally, sediment and water flow processes are generally less degraded indicating fewer potential limiting factors which would undermine opportunities for protection.

The Tolt River planning unit presents some relatively good opportunities for protection of water flow processes and in some AUs, particularly just below the reservoir and at the confluence with the Snoqualmie River, multiple benefits can be accrued for high value salmonid habitats. However, sediment process degradation due to logging activities in the North fork and just below the reservoir in the South Fork could undermine protection, particularly for instream habitat projects, and so should be accounted for in project strategies.

**Table 17. Planning unit (PU) comparison across assessments of the Snoqualmie basin.**

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Salmonid Habitats Assessment | Management Considerations |
|---|---|---|---|---|---|
| **Upper Snoqualmie** (Southern, Middle and Northern Forks of the Snoqualmie above the falls) | **Overall water flow**:<br>Highest ranked AUs located in the Middle Fork and upper North Fork Snoqualmie.<br><br>Ranks 1st out of 6 PUs in the basin, 3rd out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage and discharge in the Lower Middle Fork. recharge and delivery in the upper reaches of all 3 forks | **Overall water flow**:<br>Highest ranked (most degraded) AUs located in the lower South fork.<br><br>Ranks 6th (least degraded) out of 6 PUs in the basin, 14th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, discharge, recharge and delivery in Lower South Fork. recharge also in upper South Fork and lower Middle Fork | Upper Snoqualmie planning unit ranks 5th out of 6 PUs in the basin, 11th out of 16 in the WRIA for degradation to sediment processes. | Ranks 5th out of 6 in the basin, 10th out of 16 in the WRIA for local salmonid habitat value (WHI). | **<u>Water flow</u>**<br><br>**Overall land use recommendation**<br>Overall: Protection<br>- <u>North Fork:</u> Highest Protection & Restoration & Develop<br>- <u>Middle Fork</u>: Highest Protection<br>- <u>South Fork</u>: Protection & Restoration<br><br>**Priority water flow processes to protect and restore**:<br>- <u>North Fork</u>: protection of delivery & recharge; restoration of delivery & recharge processes in mid reaches<br>- <u>Middle Fork</u>: restoration of storage; protection of delivery and recharge processes<br>- <u>South Fork</u>: protection of delivery & recharge processes |

Table 17 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Salmonid Habitats Assessment | Management Considerations |
|---|---|---|---|---|---|
| **Mainstem Snoqualmie** | **Overall water flow**:<br>No highest ranked AUs, some moderate to moderate-high AUs in the lower mainstem area.<br>Ranks 5th out of 6 PUs in the Snoqualmie basin, 12th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**:<br>surface storage, discharge | **Overall water flow**:<br>Ranks as most degraded PU out of 6 in the basin, 4th out of 16 in the WRIA<br><br>**Contains highest ranked AUs for**:<br>surface storage, recharge, discharge, delivery | Ranked 3rd for degration to sediment out of 6 PUs in the Snoqualmie basin, 5th out of 16 in the WRIA. | Ranks 4th out of 6 PUs in the basin and 8th out of 16 in WRIA 7 for local salmonid habitat value (WHI | **Water flow**<br>**Overall land use recommendation**: Restoration & Development<br>**Priority water flow processe to protect and restore**: restore storage & discharge processes |

Table 17 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Raging River** | **Overall water flow**: All AUs are lowest ranked. Ranks 3rd out of 6 PUs in the basin, 9th out of 16 in the WRIA. **Contains highest ranked AUs for**: None High, but Moderate-high AUs for delivery in upper watershed | **Overall water flow**: Lower watershed has moderate-high ranked AUs . Ranks 3rd out of 6 PUs in the basin, 9th out of 16 in the WRIA **Contains highest ranked AUs for**: recharge, discharge in the lower watershed | Ranked as most degraded out of 6 PUs for sediment in the basin, 2nd most degraded out of 16 in the WRIA. | Ranks 3rd out of 6 PUs in the basin, 6th out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | <u>**Water flow**</u><br>**Overall land use recommendation:** Conservation & Development<br>**Priority water flow processes to protect and restore**: Protection & conservation of delivery and recharge processes in the upper watershed |

Table 17 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Salmonid Habitats Assessment | Management Considerations |
|---|---|---|---|---|---|
| **Mid-Snoqualmie**<br><br>(Tokul and Griffin Creeks) | **Overall water flow**: Some moderate ranked AUs in the upper portions of the watershed. Ranks 4th out of 6 PUs in the Snoqualmie basin, 11th out of 16 in the WRIA.<br>**Contains highest ranked AUs for**: surface storage and discharge | **Overall water flow**: generally AUs rank low for degradation.<br><br>Ranks 5th out of 6 PUs in the Snoqualmie basin, 11th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: discharge | Ranked as least degraded PU out of 6 for sediment processes in the Snoqualmie basin and least degraded in the WRIA (out of 16 PUs). | Ranks 2nd out of 6 PUs in the basin, 5th out of 16 in WRIA 7 for relative salmonid habitat value (mean WHI). | **Water flow**<br>**Overall land use recommendation**: Conservation & Development<br>**Priority water flow processes to protect and restore**: protection and restoration of surface storage and discharge processes. |

Table 17 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Tolt River Planning Unit** (combined Mainstem, North and South Forks) | **Overall water flow**: Highest and moderate-high ranked AUs in the upper North and South Forks.<br>Ranks 2nd out of 6 PUs in the Snoqalmie basin 5th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage discharge, delivery. | **Overall water flow**: Some moderate- high AUs in the upper North and South forks, and lower watershed near the mainstem Snoqualmie.<br>Ranks as 4th most degraded PU out of 6 in the basin, 10th out of 16 in the WRIA.<br>**Contains highest ranked AUs for**:<br>surface storage | Ranked 2nd (most degraded) for degration to sediment Snoqualmie River basin, 3rd in the WRIA. | Ranks 6th in the basin, 12th in the WRIA for local salmonid habitat value (WHI).<br><br>. | **Water flow**<br>**Overall land use recommendation:** Protection & Restoration<br>**Priority water flow processes to protect and restore:**<br>North Fork: Restoration of delivery processes, protection of recharge and discharge processes<br>South Fork: Protection & restoration of delivery & recharge<br>Mainstem Tolt: Protection and restoration of surface storage and discharge |

Table 17 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Salmonid Habitats Assessment | Management Considerations |
|---|---|---|---|---|---|
| **Lowland Mid-Snoqualmie Planning Unit** (Cherry Creek and Patterson Creek) | **Overall water flow**: generally low to moderate importance AUs.<br><br>Ranks 6th out of 6 PUs in the Snoqualmie basin, 13th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, discharge | **Overall water flow**: Highest ranked AUs located in Patterson creek, moderate-high AUs in Cherry creek.<br><br>Ranks 2nd most degraded PU out of 6 in the Snoqualmie basin, 6th most degraded out of 16 in the WRIA<br><br>**Contains highest ranked AUs for**: discharge, recharge, surface storage | Ranked 4th out of 6 PUs for degration to sediment in the Snoqualmie basin, 9th out of 16 in the WRIA. | Cherry and Patterson creeks combined are the highest ranked planning unit in the basin out of 6 PUs, and also the WRIA (out of 16) for local salmonid habitat value (mean WHI). | **<u>Water flow</u>**<br><u>Cherry Creek:</u><br>**Overall land use recommendation**: Conservation & Development<br><br>**Priority water flow processes to protect and restore:** Restoration of discharge and surface storage processes<br><br><u>Patterson Creek:</u><br>**Overall land use recommendatio**n: Development<br>**Priority water flow processes to protect and restore**:<br>Restoration of discharge and surface storage processes |

# Skykomish Basin

The Skykomish basin is comprised of the freshwater systems extending from the Cascade crest at Stevens Pass on Highway 2, east to the confluence with the Snoqualmie river near the city of Monroe (Figure 34). The basin consists of the planning units representing the major sub-basins in the watershed: The South Fork Skykomish, the North Fork Skykomish, the Lower Mid-Skykomish, the Sultan River, Woods Creek and the Skykomish mainstem. The water flow results presented here represent a comparison of only those AUs in the Skykomish basin. sediment process degradation and local salmonid habitats assessments presented at this scale use the WRIA 7 extent results.

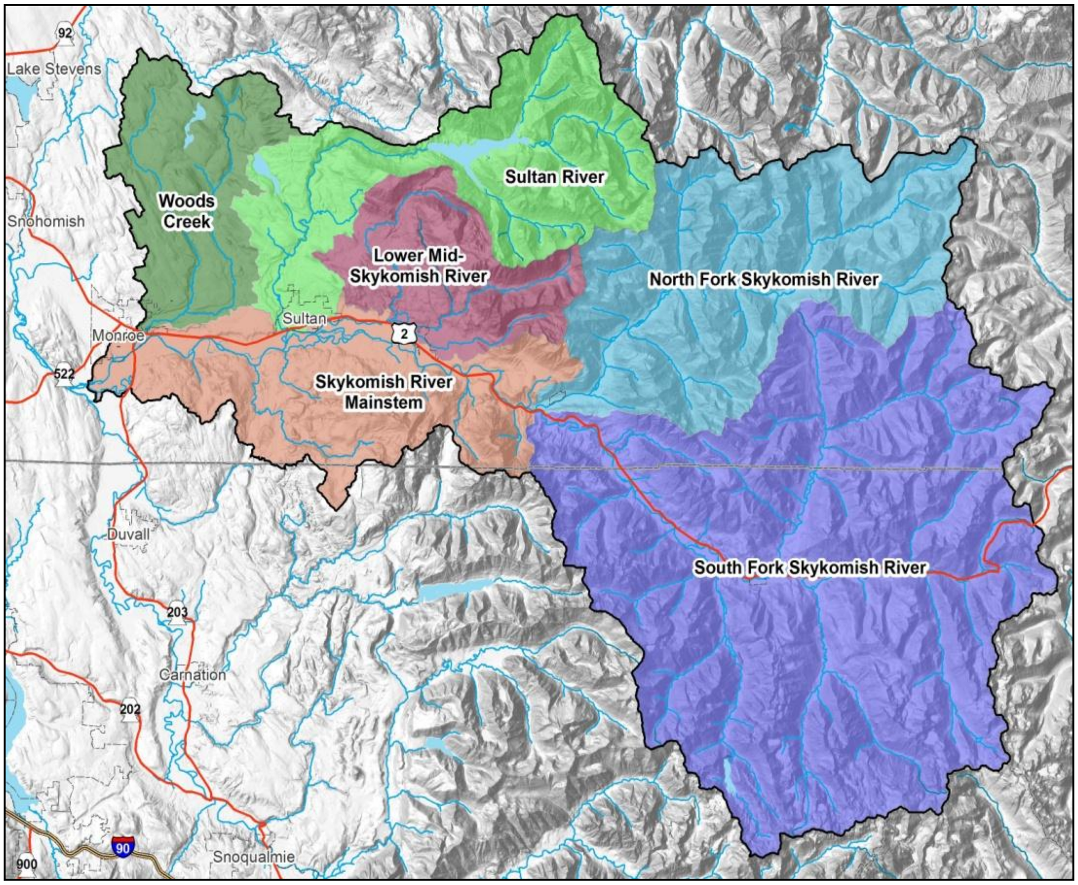



**Figure 34. Planning units of the Skykomish basin.**

## Water Flow Process Assessment results for the Lower Snohomish Basin

The following is a description of the scale 2 water flow assessment for the Skykomish basin. Results for the water flow assessment at this scale do not use landscape groups and AUs are compared only within the Skykomish basin. AU rankings presented at this scale are not directly comparable to results at other scales or between the two other basins.

## Overall Water Flow Processes

Across the Skykomish basin, the highest ranked AUs for overall importance to water flow processes are generally found in the upper reaches of the South Fork Skykomish, North Fork Skykomish, and Sultan River planning units as well as the Skykomish mainstem (Figure 35). Table 18 below compares average rankings across all planning units in the basin. The North Fork Skykomish and South Fork Skykomish rank highest in the Skykomish basin for overall importance to water flow processes.

Highest ranked AUs for overall degradation to water flow processes are generally located in the Woods Creek, Skykomish mainstem and lower watershed areas of the Sultan River, Wallace River, Olney Creek and May Creek. Additionally, highest and moderate-high ranked AUs for overall degradation are located in the mainstem of the South Fork Skykomish. Woods Creek and the Skykomish River mainstem rank as the most degraded planning units in the Skykomish basin.

**Table 18. Average assessment unit (AU) rank for overall water flow processes for planning units of the Skykomish basin.**

| | | | Overall Importance to water flow | | | Overall Degradation to Water Flow | | |
|---|---|---|---|---|---|---|---|---|
| Basin | Planning Unit | # of AUs | Average AU Rank WF_M1 | Basin Rank | WRIA Rank | Average AU Rank WF_M2 | Basin Rank | WRIA Rank |
| Skykomish River basin | Lower Mid-Skykomish River | 7 | 132 | 4 | 6 | 177 | 4 | 13 |
| | Skykomish River Mainstem | 14 | 145 | 5 | 8 | 135 | 2 | 8 |
| | Sultan River | 12 | 117 | 3 | 4 | 172 | 3 | 12 |
| | North Fork Skykomish River | 15 | 40 | 1 | 1 | 238 | 6 | 16 |
| | South Fork Skykomish River | 38 | 60 | 2 | 2 | 212 | 5 | 15 |
| | Woods Creek | 10 | 196 | 6 | 15 | 112 | 1 | 7 |
| | *basin* | *96* | *115* | | | *174* | | |

## Delivery Processes

Across the Skykomish basin the highest ranked AUs are primarily found in the upper reaches of the South Fork Skykomish, North Fork Skykomish and the Sultan River due to increased precipitation and rain-on-snow areas in these AUs. The South Fork Skykomish and North Fork Skykomish planning units generally rank highest across the basin for importance to delivery processes with Woods creek ranking lowest.

Highest ranked AUs for degradation to delivery processes are primarily located in Woods Creek, the Skykomish mainstem, lower Sultan River, Olney Creek and Wallace River along with the mainstem of the South Fork planning units. This is primarily due to increased impervious surface and forest loss in these AUs. Woods Creek and the Skykomish mainstem rank highest across the basin for degradation to delivery processes.

## Surface Storage Processes

Across the Skykomish basin highest ranked AUs for importance to surface storage processes primarily occur in the Woods Creek, Skykomish mainstem and lower reaches of the Sultan and Lower-mid Skykomish Planning units. This is due to higher relative proportion of wetlands, lakes and floodplains in these AUs.  Woods Creek and the Skykomish mainstem planning units generally rank highest for importance to surface storage processes.

Highest ranked AUs for degradation to surface storage processes are primarily located in the Woods creek, Skykomish maisntem and Lower-mid Skykomish planning units.  There are also signficiant areas of degraded storage processes in the South Fork Skykomish mainstem and the lower North Fork Skykomish.  Degradation to storage is generally due to greater loss of historic wetlands and greater channelization and disconnection of streams from floodplains.

**Recharge**

Highest ranked AUs for importance to recharge processes are generally located in the upper watersheds of the North Fork Skykomish and South Fork Skykomish planning units, with some significant areas in the upper watershed of the Sultan River.  This is due to higher relative precipitation and areas of high permiability surface deposits and soils in these AUs relative to the rest of the Skykomish basin.  The Woods Creek and Skykomish mainstem generally rank lowest for importance to recharge processes.

Across the Skykomish basin the highest ranked AUs for degradation to recharge processes are primarily locted along the Skykomish mainstem, lower Woods creek, lower Sultan River. Sigificant areas of degradation to recharge are found in the AUs along the South Fork Skykomish mainstem and Beckler River portions of the South Fork Skykomish planning unit. The degradation to recharge processes is primarily due to impervious surface and higher intensity development on more permeable deposits.

**Discharge**

Across the Skykomish basin highest ranked AUs for importance to discharge processes are primarily located in the Skykomish river mainstem, Woods Creek and lower portions of the Sultan River and Olney Creek due to the presence of slope wetlands and floodplains intersecting permeable soil deposits in these AUs. The Skykomish mainstem ranks highest for importance to discharge processes.

AUs ranked highest for degradation to discharge processes are primarily located in the Woods Creek, Skykomish mainstem and Lower mid-Skykomish planning units. This is due to greater development within or adjacent to slope wetlands and floodplains with high permeability soils, higher density of roads and ditches, and groundwater wells which impact those processes. The Skykomish mainstem and Woods Creek rank highest for degradation to discharge processes across the Skykomish basin.

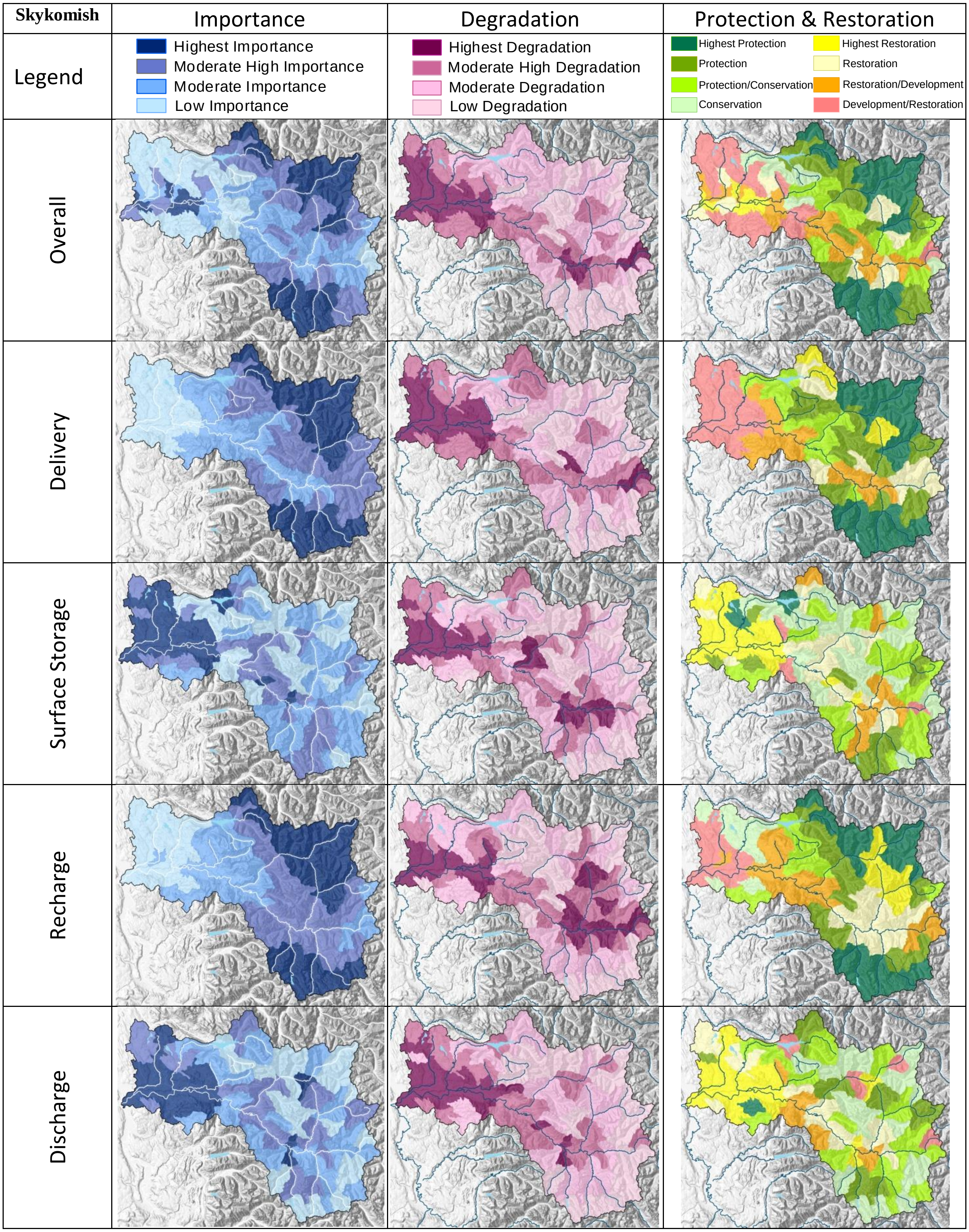



**Figure 35. Scale 2 water flow assessment results for the Skykomish basin.**

## Sediment Process Degradation Assessment results for the Skykomish Basin

Across the Skykomish basin, the Skykomish mainstem ranks generally highest for degradation to sediment processes, followed by the Sultan River and the Lower Mid-Skykomish planning units (Figure 36 & Table 19). Given the structure of the sediment degradation model, it is helpful to understand the land use and landscape context of an AU to determine the likely cause behind relatively higher levels of degradation.

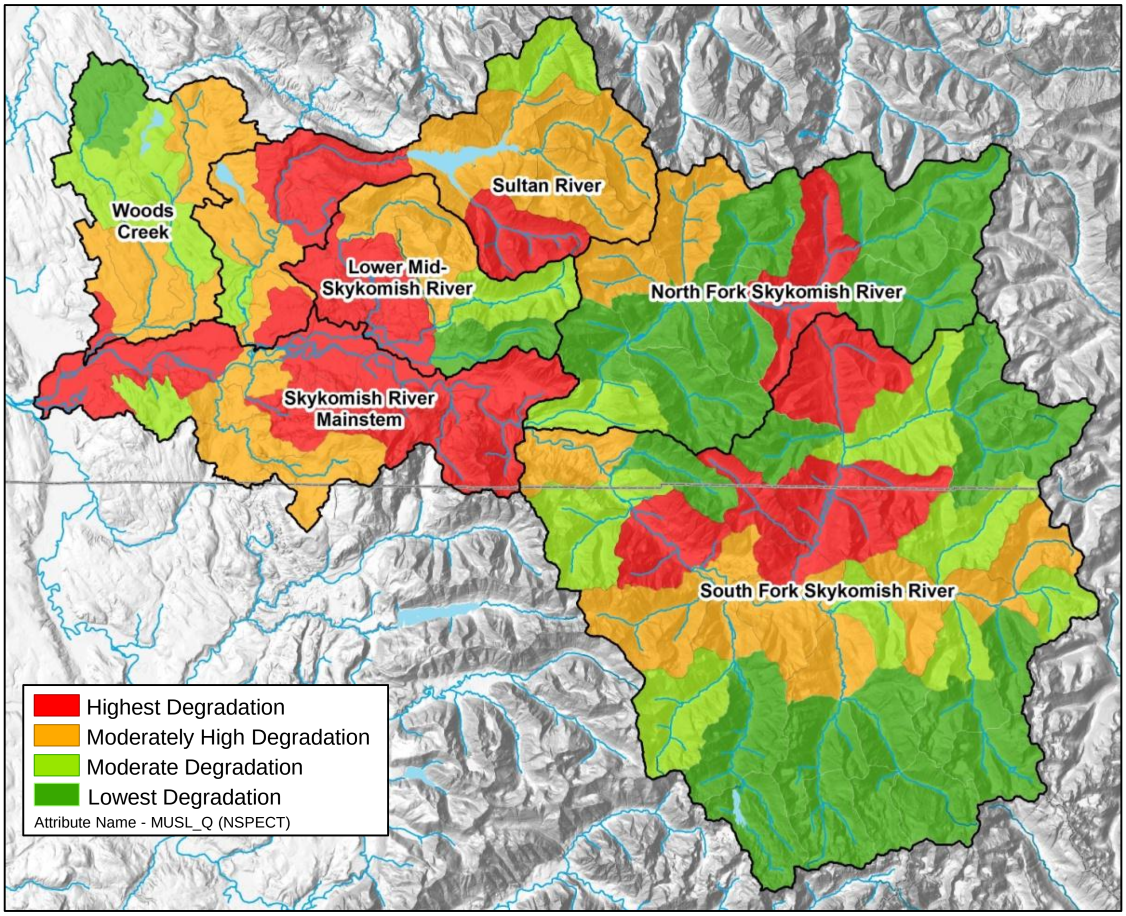



**Figure 36. Scale 1 sediment process degradation results for the Skykomish basin.**

The Skykomish basin has three general categories of degraded sediment processes:

- Mountainous areas with steep slopes, high precipitation, erodible soils and intensive forestry activities;
- Lowland floodplain areas, with erodible soils, moderate to high precipitation with extensive flooding and intense agricultural activities;
- Lowland floodplain areas with erodible soils, moderate to high precipitation and urban or rural residential development.

**Table 19. Average assessment unit (AU) rank for sediment degradation for planning units of the Skykomish basin.** Note, results are at the WRIA scale, where the most degraded AU received a rank of one. Therefore a lower numerical value for average rank implies a higher level of average degradation.

| Basin | Planning Unit | Average Rank (Sediment Degradation) | Basin Rank | WRIA Rank |
|---|---|---|---|---|
| Skykomish River Basin | Lower Mid-Skykomish River | 106 | 3 | 7 |
| | Skykomish River Mainstem | 63 | 1 | 1 |
| | Sultan River | 89 | 2 | 4 |
| | North Fork Skykomish River | 188 | 6 | 15 |
| | South Fork Skykomish River | 157 | 5 | 12 |
| | Woods Creek | 124 | 4 | 8 |
| | *basin average* | *121* | | |

For the mountainous category, the results suggest that the upper watershed of the Sultan River, particularly just downstream of Spada Lake, as well as the Bechler River and some associated tributaries, of the Upper south Fork Skykomish planning unit are highly degraded due to commercial logging activities. In the lowland floodplain areas of the Skykomish River mainstem planning unit between the towns of Gold Bar and Monroe, sediment process degradation is due to a combination of rural residential, and intense agricultural and forestry activities, all of which occur to a high degree in these areas.

## Salmonid Habitat Assessment results for the Skykomish Basin

The most valuable planning unit for salmonid habitats, based on mean WHI, in the Skykomish basin is Woods Creek (Table 20), and Woods Creek is the second most valuable planning unit in WRIA 7. The Woods Creek planning unit mostly consists of high value habitat: three of its 10 AUs are in the top 10% of all AUs in the WRIA, and 3 others are in the top 30% of all AUs (Figure 37). The AU containing Lake Chaplain is the only AU with low value salmonid habitat in that planning unit.

The Skykomish basin contains 95 AUs. The Skykomish mainstem planning unit had the three highest ranked AUs and four of the top five AUs in the basin. Two of the top ten AUs in the basin are located in the Sultan River planning unit. The least valuable planning unit in this basin is the South Fork. This result is mostly due to low salmonid species density above Sunset Falls. Anadromous fish runs above the falls are artifical, and artifical runs were discounted in our calcualtion of WHI. Nevetheless, five of the basin's top 20 AUs were in the Upper South Fork. This was mostly due to high quality habitat for resident salmonids.

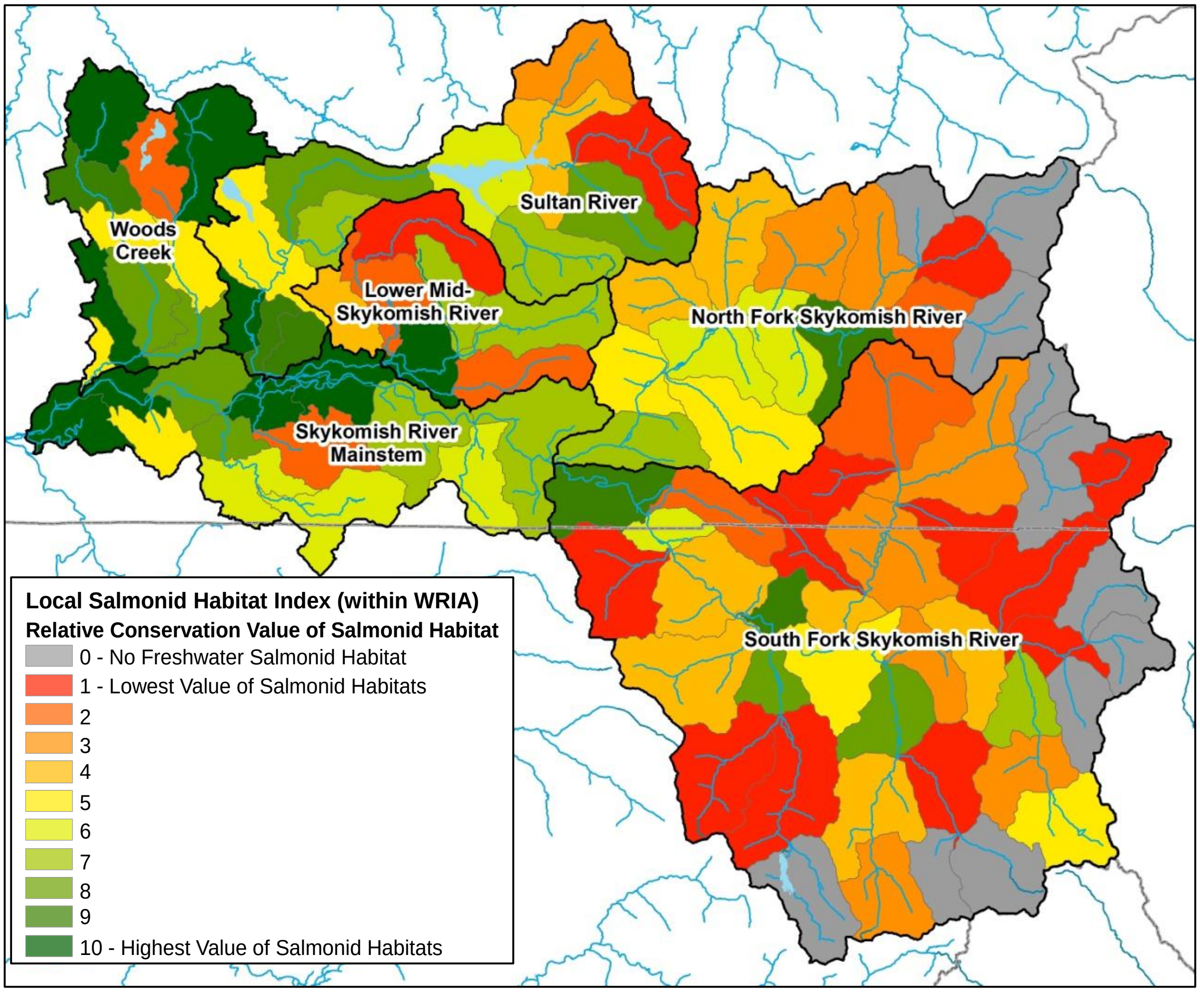



**Figure 37. Local salmonid habitat index (WHI) for each AU in the Skykomish basin.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Table 20. Mean rank for the local salmonid habitat assessment (WHI) for planning units of the Skykomish basin.**

| Basin | Planning unit | Number of AUs | mean WHI | Basin rank mean WHI | WRIA 7 rank mean WHI |
|---|---|---|---|---|---|
| **Skykomish** | Woods Creek | 10 | 0.78 | 1 | 2 |
| | Skykomish Mainstem | 14 | 0.71 | 2 | 4 |
| | Sultan River | 12 | 0.60 | 3 | 7 |
| | Lower Mid-Skykomish | 7 | 0.49 | 4 | 11 |
| | North Fork Skykomish | 15 | 0.41 | 5 | 14 |
| | South Fork Skykomish | 38 | 0.28 | 6 | 15 |

## Planning unit Comparison accross Assessments for the Skykomish Basin

Table 21 below summarizes the assessment results for the Skykomish basin. Recall that the water flow assessment results presented below are those from the scale 2 assessment, including the management considerations. Comparisons of planning unit ranks utilize the scale 1 results across all three categories of assessment (water flow, sediment, salmonid habitats). Following is a brief description of the planning units which appear to provide particularly good protection and restoration opportunities in the Skykomish basin.

The North Fork Skykomish planning unit is highly ranked for importance to overall water flow processes and is relatively low ranked for degradation to those processes indicating excellent oportunities for protection. Though overall the planning unit is not very highly ranked for salmonid habitats, some AUs at the confluence with the mainstem, and West Cady Creek in the upper watershed are among the highest ranked in the WRIA. Additionally, the planning unit has very few AUs which appear to be degraded for sediment processes, so hydrologic protection measures targeted for multiple benefits to salmonids are unlikely to be undermined by current land uses as long as timber activities on National Forest Lands are minimal and apply appropriate best management practices. That said, the highest value AU for local salmonid habitats is also highly ranked for degradation to sediment process, so limiting factors could be present for protection or restoration activities focused on instream habitats in or downstream of that AU. Given the planning unit is predominantly covered by National Forest lands it may be difficult to find additional opportunities for protection beyond working with timber managers to ensure appropriate best management practices.

The South Fork Skykomish planning unit is highly ranked for importance to overall water flow processes and is relatively low ranked for degradation to those processes with the exception of some AUs located along and just upsloap of the mainstem near the town of Skykomish and upstream in timber harvest areas.  There are some AUs ranked moderate to high for salmonid habitats, particularly around the town of Skykomish and at the confluence of the North and South Forks of the Skykomish river near the town of Index which could provide protection opportunities with muliple benefits for water flow and salmonids on private lands. In general, the planning unit ranks low for degradation to sediment processes, though there are some highly ranked AUs in the Beckler River drainage and around the town of Skykomish, downstream of which protection aimed at benefiting salmonids could be undermined by degraded processes.

**Table 21. Planning unit (PU) comparison across assessments in the Skykomish basin.**

| Planning unit | Water Flow Importance | Water Flow Degradation | Sedimen Degradation | Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Skykomish Mainstem** | **Overall water flow**: Some highest ranked and moderate-high ranked AUs along the mainstem of the Skykomish.<br><br>Ranks 5th out of 6 PUs in the Skykomish basin, 8th out of 16 in the WRIA<br><br>**Contains highest ranked AUs for**:<br>surface storage, discharge | **Overall water flow**:<br>All AUs rank moderate-high to highest for degradation to overall water flow processes<br><br>Ranks as 2nd most degraded out of 6 PUs in the Skykomish basin, 8th out of 16 in the WRIA<br><br>**Contains highest ranked AUs for**: All processes | Ranked as most degraded out of 6 PUs for sediment processes in the Skykomish basin and in the WRIA (out of 16). | Ranks 2nd in the basin out of 6 PUs and 4th in WRIA 7 for local salmonid habitat value (WHI). | <u>**Water flow**</u><br>**Overall land use recommendation**: Restoration & Development<br><br>**Priority water flow processes to protect and restore**:<br>Restore surface storage and discharge |
| **Woods Creek** | **Overall water flow**: AUs generally lowest importance, but some are moderate-high to high near Skykomish mainstem.<br><br>Ranks last out of 6 PUs in the Skykomish basin, 15th out of 16 in the WRIA.<br>**Contains highest ranked AUs for**:<br>surface storage, discharge | **Overall water flow**: AUs across the planning unit are moderate-high to highest ranked for overall degradation<br><br>Ranks as most degraded PU in the Skykomish basin, 7th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, recharge, discharge, delivery | Ranked 4th out of 6 PUs for degration to sediment in the Skykomish basin, 8th out of 16 in the WRIA. | Ranks 1st in the basin out of 6 PUs, 2nd in WRIA 7 for local salmonid habitat value (WHI). | <u>**Water flow**</u><br>**Overall land use recommendation**: Restoration & Development<br><br>**Priority water flow processes to protect and restore**: Restore surface storage and discharge processes |

Table 21 cont.

| Planning unit | Water Flow Importance | Water Flow Degradation | Sedimen Degradation | Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Sultan River** | **Overall water flow**: Moderate-high to highest ranked AUs generally cover the upper watershed and adjacent to Skykomish mainstem.<br><br>Ranks 3rd out of 6 PUs in the Skykomish basin, 4th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, recharge and delivery in upper watershed, discharge in the lower watershed | **Overall water flow**: Moderate-high to hightest ranked AUs for degradation in the lower watershed.<br><br>Ranks as 3rd most degraded out of 6 PUs in the Skykomish basin, 12th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage , recharge, discharge, delivery in the lower watershed | Ranked second highest out of 6 PUs fo21 cont.r degration to sediment processes in the Skykomish basin, 4th out of 16 in the WRIA. | Ranks 3rd out of 6 PUs in the basin and 7th out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | **Water flow**<br>**Overall land use recommendation**: Protection in Upper Watershed, Restoration & Development in the lower watershed<br><br>**Priority water flow processes to protect and restore**:<br>Upper watershed: Protection of surface storage and recharge<br>Lower watershed: Restoration of discharge and surface storage |

Table 21 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **Lower Mid-Skykomish** (May Creek) | **Overall water flow**: Some moderate to moderate-high ranked AUs in the lower Olney creek and Wallace river.<br><br>Ranks 4th out of 6 PUs in the basin, 6th in the WRIA<br><br>**Contains highest ranked AUs for**: surface storage, discharge | **Overall water flow**: Highest ranked AUs in the Bear Crk. and lower Wallace tributaries.<br>Ranks as 4th most degraded out of 6 PUs in the Skykomish basin, 13th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: surface storage, recharge, discharge, delivery | Ranked 3rd out of 6 PUs for degration to sediment in the Skykomish basin, 7th out of 16 in the WRIA. | Ranks 4th out of 6 PUs in the basin and 11th out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | <u>**Water flow**</u><br>**Overall land use recommendation**: Restoration & Development<br><br>**Priority water flow processes to protect and restore**: restoration of surface storage and discharge |

| Planning unit | Water Flow Importance | Water Flow Degradation | Sedimen Degradation | Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **North Fork Skykomish** | **Overall water flow**: Moderate-high and Highest ranked AUs cover the upper watershed<br><br>Ranks 1st out of 6 PUs in the Skykomish basin and 1st out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: recharge and delivery; one highest ranked AU for discharge | **Overall water flow**: All AUs rank lowest to moderate for degradation.<br><br>Ranks as the least degraded out of 6 PUs in the Skykomish basin and 16th in the WRIA<br><br>**Contains highest ranked AUs for**: surface storage in lower watershed near the mainstem Skykomish | Ranked last out of 6 PUs for degration to sediment processes in the Skykomish basin, 15th out of 16 in the WRIA. | Ranks 5th out of 6 PUs in the basin, 14th out of 16 in WRIA 7 for local salmonid habitat value (meanWHI). | **<u>Water flow</u>**<br>**Overall land use recommendation**: Highest Protection<br><br>**Priority WF processes to protect and restore**: Protection of delivery, protection and restoration of recharge |

Table 21 cont.

| Planning Unit | Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Management Considerations |
|---|---|---|---|---|---|
| **South Fork Skykomish Planning Unit** | **Overall water flow**: Highest ranked and moderate-high ranked AUs throughout the upper watershed<br><br>Ranks 2nd out of 6 PUs in the Skymkomish basin, 2nd out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: recharge, delivery | **Overall water flow**: Some moderate-high to highest ranked AUs along the mainstem South Fork Skykomish.<br><br>Ranks as 5th most degraded out of 6 PUs in the Skykomish basin, 15th out of 16 in the WRIA.<br><br>**Contains highest ranked AUs for**: recharge, discharge, surface storage, delivery | Ranked 5th out of 6 PUs for degration to sediment in the Skykomish basin, 12th out of 16 in the WRIA. | Ranks 6th out of 6 PUs in the basin, 15th out of 16 in WRIA 7 for local salmonid habitat value (mean WHI). | **Water flow**<br>**Overall land use recommendation**: Protection & Restoration<br><br>**Priority water flow processes to protect and restore**:<br>Northern Tributaries: Restore recharge, protect & restore delivery<br>Southern Tributaries: Protect recharge and delivery<br>South Fork mainstem: Restore surface storage |

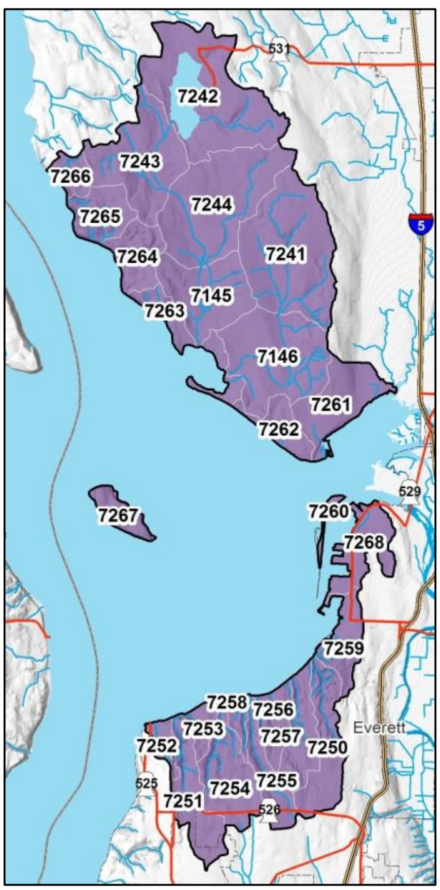
# Scale 3 Planning Unit Summaries

## Lower Snohomish Basin Planning Units

### Puget Sound Drainages Planning Unit

The Puget Sound Drainages planning unit (Figure 38) is comprised of the Tullalip Creek  and Mission Creek drainages and small coastal drainages on the northern and southern side of Possession Sound.  In comparison to the rest of the Lower Snohomish basin (Figure 39), the AUs in the Puget Sound Drainages generally rank lowest for overall importance and moderate for overall degradation.  As such, the general land use recommendation is *Protection & Conservation in the Northern AUs around the Tulalip drainage, and Lowest Restoration & Development in the southern coastal drainages*.

Using the scale 2 basin results (Figure 27) for the sub-components of the water flow process we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AUs relative Importance and degradation.




When assessing the Puget Sound Drainages for predominant areas of highest importance to specific water flow processes we can target the following:  *Protection of surface storage, recharge and discharge in Northern Drainages around Tulalip creek.*

**Figure 38. The assessment units of the Puget Sound Drainages planning unit.**

**Scale 3 water flow results**
The scale 3 water flow assessment for the Puget Sound Drainage planning unit (Figure 40) uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

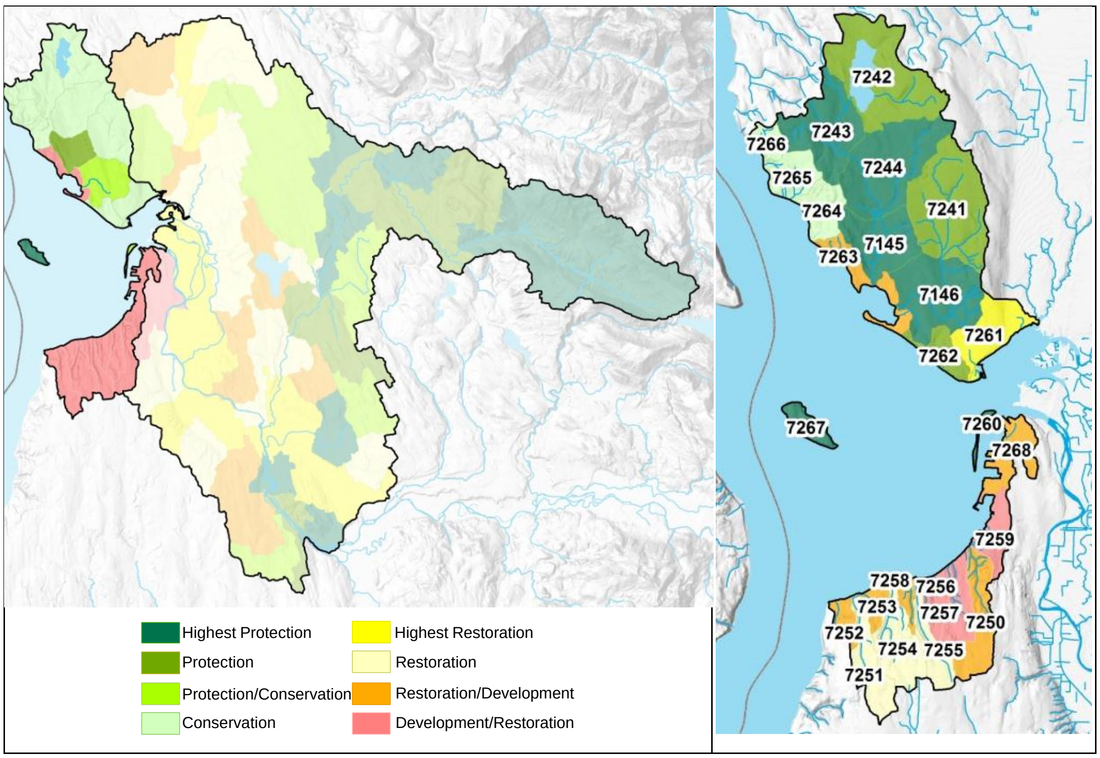



**Figure 39. The scale 2 (left panel) and scale 3 (right panel) overall water flow Protection & Restoration results for the Puget Sound Drainages planning unit.**

The scale 3 assessment results can be used to determine, specific to the Puget Sound Drainages planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Puget Sound Drainages planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs. The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As such the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

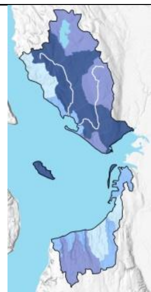
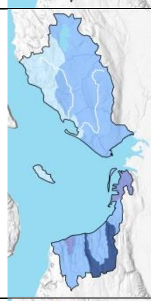
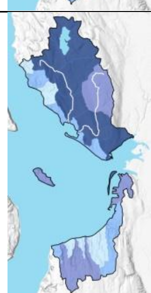
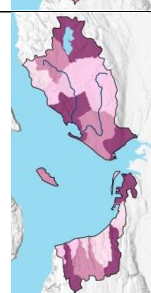
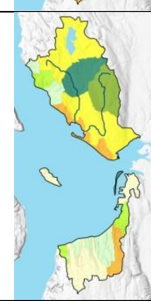
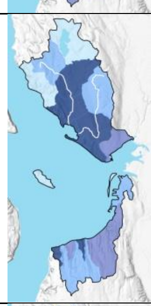
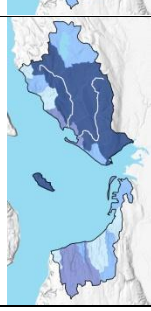
| Puget Sound Drainages | Importance | Degradation | Protection & Restoration |
|---|---|---|---|
| Legend | Highest Importance<br>Moderate High Importance<br>Moderate Importance<br>Low Importance | Highest Degradation<br>Moderate High Degradation<br>Moderate Degradation<br>Low Degradation | Highest Protection<br>Protection<br>Protection/Conservation<br>Conservation<br>Highest Restoration<br>Restoration<br>Restoration/Development<br>Development/Restoration |
| Overall |  |  |  |
| Delivery |  |  |  |
| Surface Storage |  |  |  |
| Recharge |  |  |  |
| Discharge |  |  |  |

**Figure 40. Scale 3 water flow assessment results for the Puget Sound Drainages**

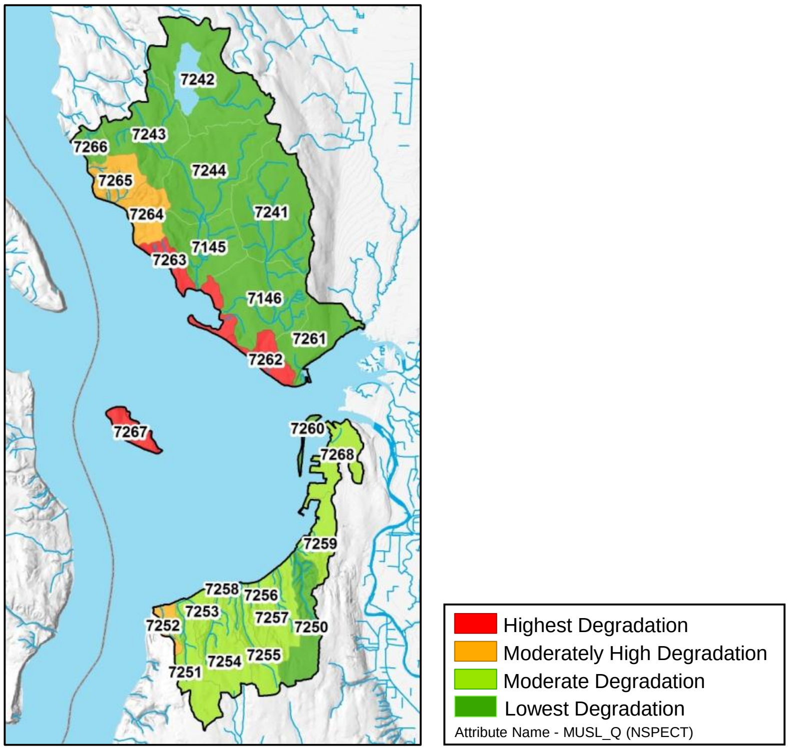



**Figure 41. Scale 1 results of sediment process degradation for the Puget Sound Drainages planning unit.**

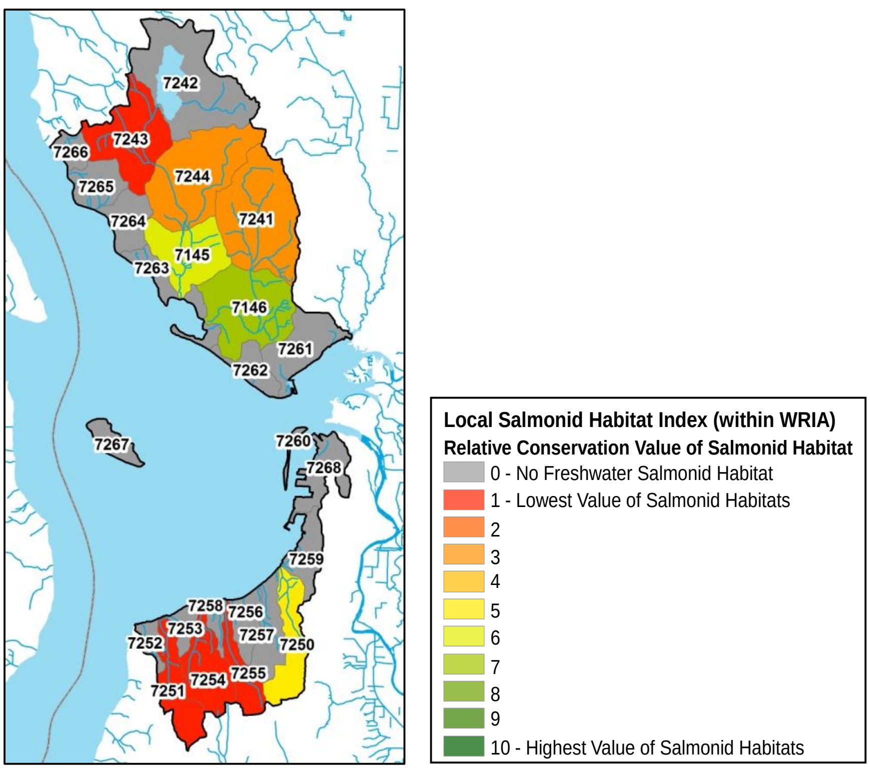



**Figure 42. Scale 1 results of the local salmonid habitat index (WHI) for the Puget Sound Drainages planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA.

**Integrating assessments across scales to inform priority AUs for protection**

Figure 43 and Table 22 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 41) and local salmonid habitats (using scale 1 WRIA 7 results, Figure 42) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or factors that may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 22 below summarizes the scale 2 water flow recommendations for the Puget Sound drainages which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 22. Integration of assessment results for the Puget Sound Drainages planning unit to identify priority AUs.**

<table>
<tr><th>Water Flow Importance</th><th>Water Flow Degradation</th><th>Water Quality Results – Sediment</th><th>Local Salmonid Habitats</th><th>Considerations</th></tr>
<tr>
<td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: generally around Tulalip and mission creeks, 7145, 7146, 7243, 7244, 7260, 7261, 7267</td>
<td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: almost entirely in the southern coastal drainages 7250, 7251, 7255, 7257, 7259, 7261, 7268</td>
<td>AUs meeting cutoff (top 25%) threshold: 7262, 7263, 7267</td>
<td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>none</td>
<td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>7243, 7244, 7145, 7146, 7260, (-)7267</td><td>7261</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs which have lower relative degradation in the planning unit. (-) indicates that sediment process degradation may impact habitat protection efforts.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit.</td></tr>
</table>
</td>
</tr>
<tr><td colspan="5">Basin Scale (2) considerations</td></tr>
<tr>
<td>Highest Ranked processes (from scale 2): discharge</td>
<td>Highest Ranked (most degraded) processes (from scale 2): recharge, discharge, delivery</td>
<td></td>
<td></td>
<td><u>Water flow:</u><br>Overall land use recommendation: Protection & Conservation in Northern AUs, Lowest Restoration & Development in Southern Drainages<br><br>Priority WF components to protect (and restore): Protection of surface storage, recharge and discharge in Northern Drainages around Tulalip creek.</td>
</tr>
</table>

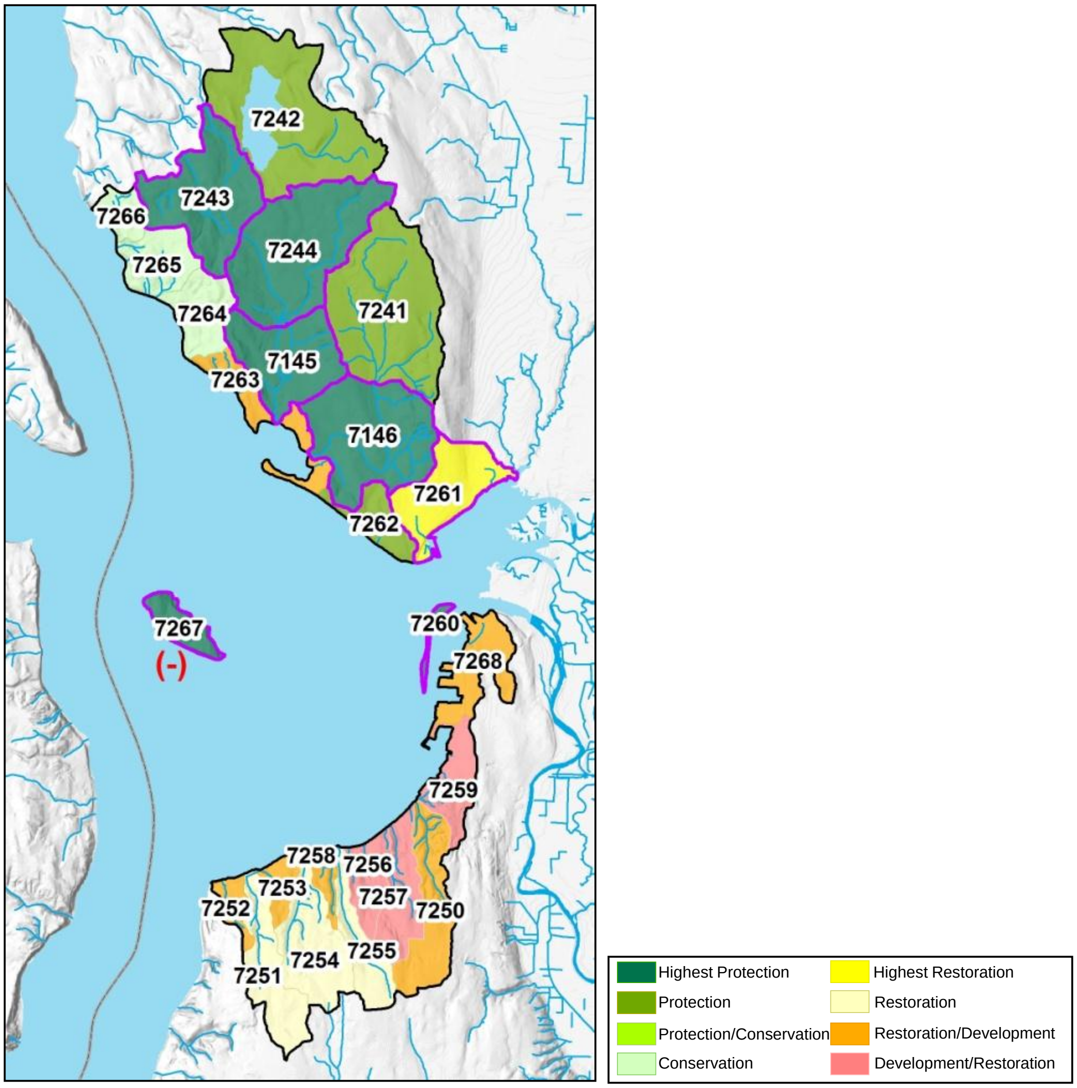



**Figure 43. Highest priority assessment units for protection of water flow processes in the Puget Sound Drainages planning unit.** (-) indicates the AU meets cutoff threshold for sediment process degradation.

## Estuary Drainages Planning Unit

The Estuary Drainages planning unit is comprised primarily of Quilceda and Allen creeks which drain into the Snohomish estuary near Marysville (Figure 44). In comparison to the rest of the Lower Snohomish basin (Figure 45), AUs in the Estuary Drainages generally rank in the middle for overall importance to water flow processes and highest for overall degradation to water flow processes. As such, the *general land use recommendation for the Estuary Drainages Planning unit is Restoration.*

Using the scale 2 basin results for the sub-components of the water flow process (Figure 27) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation. This indicates the following target: *Restoration of surface storage, recharge, and delivery.*

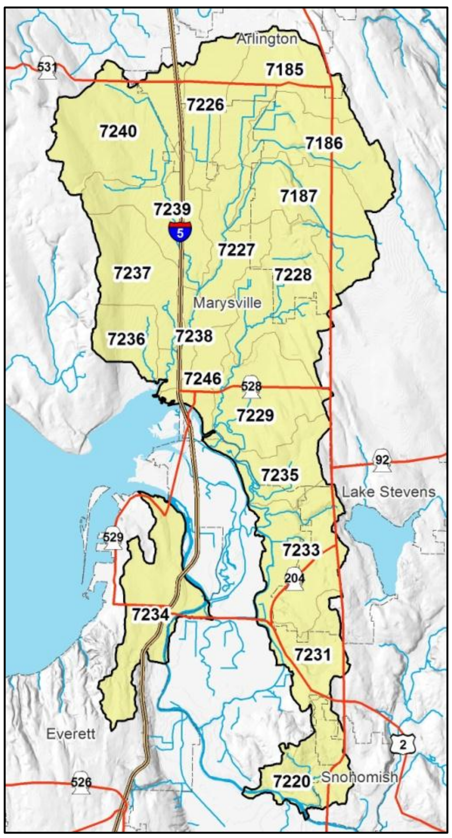



**Figure 44. The assessment units of the Estuary Drainages planning unit.**

### Scale 3 water flow results

The scale 3 water flow assessment for the Estuary Drainages planning unit (Figure 46) uses the original AUs as their size and number offer an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

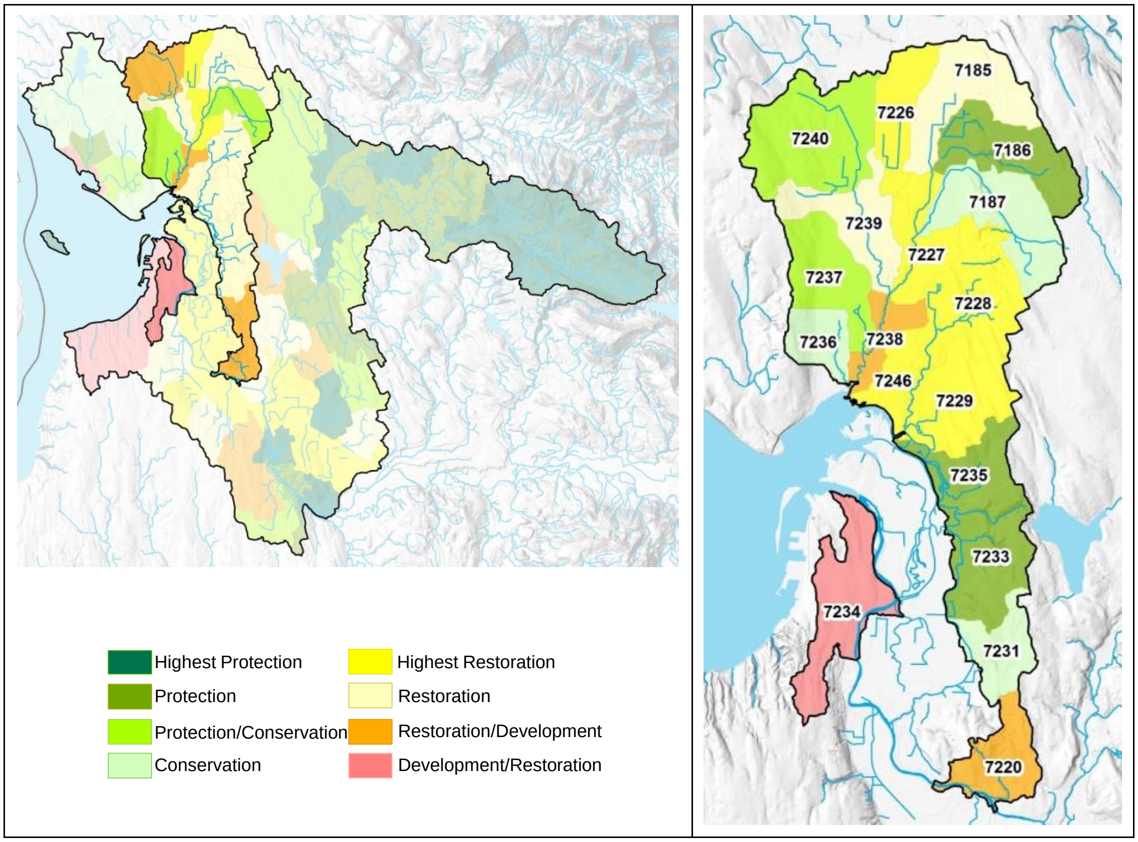



**Figure 45. The Scale 2 (left panel) and Scale 3 (right panel) overall water flow Protection & Restoration results for the Estuary Drainages planning unit.**

The scale 3 assessment results can be used to determine, specific to the Estuary Drainages planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Estuary Drainages planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs. The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As such the water flow degradation results and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

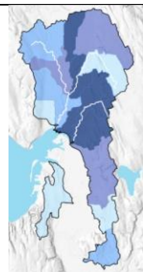
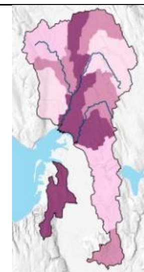
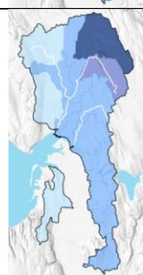
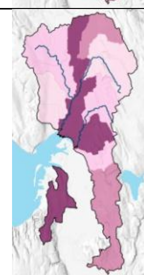
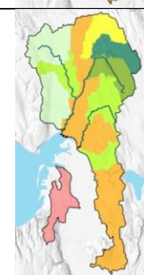
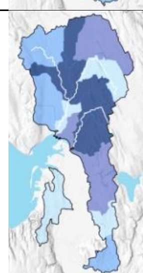
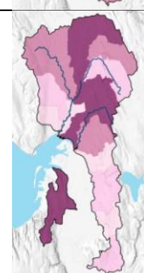
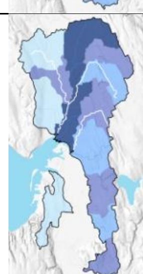
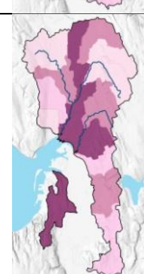
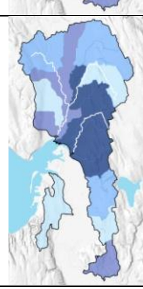
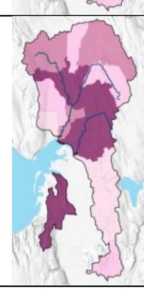
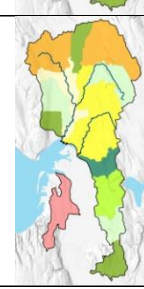
| Estuary Drainages | Importance | Degradation | Protection & Restoration |
|---|---|---|---|
| Legend | Highest Importance<br>Moderate High Importance<br>Moderate Importance<br>Low Importance | Highest Degradation<br>Moderate High Degradation<br>Moderate Degradation<br>Low Degradation | Highest Protection<br>Protection<br>Protection/Conservation<br>Conservation<br>Highest Restoration<br>Restoration<br>Restoration/Development<br>Development/Restoration |
| Overall |  |  |  |
| Delivery |  |  |  |
| Surface Storage |  |  |  |
| Recharge |  |  |  |
| Discharge |  |  |  |

**Figure 46. Scale 3 water flow assessment results for the Estuary Drainages planning unit.**

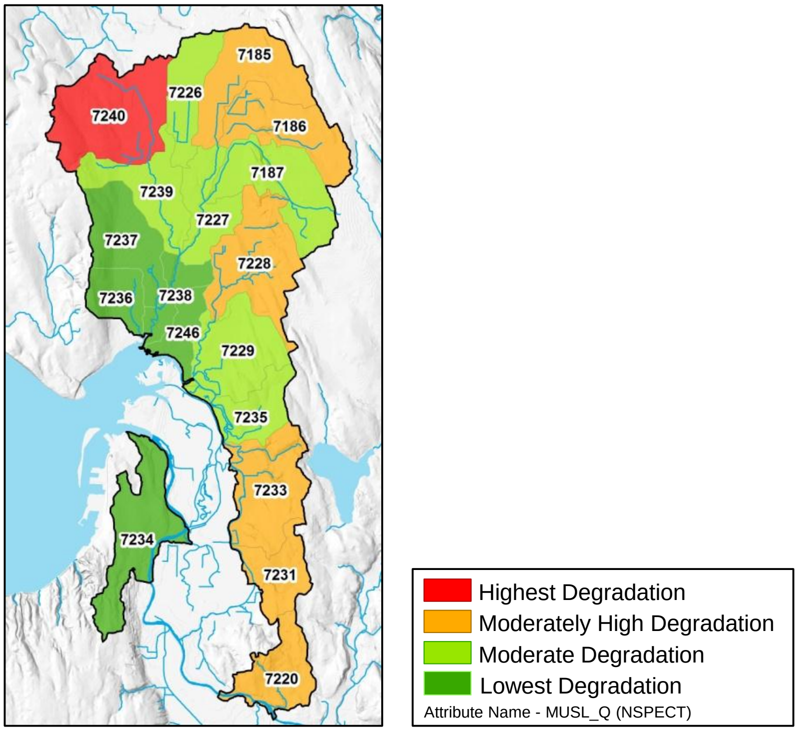



**Figure 47. Scale 1 results of sedminent process degradation for the Estuary Drainages planning unit.**

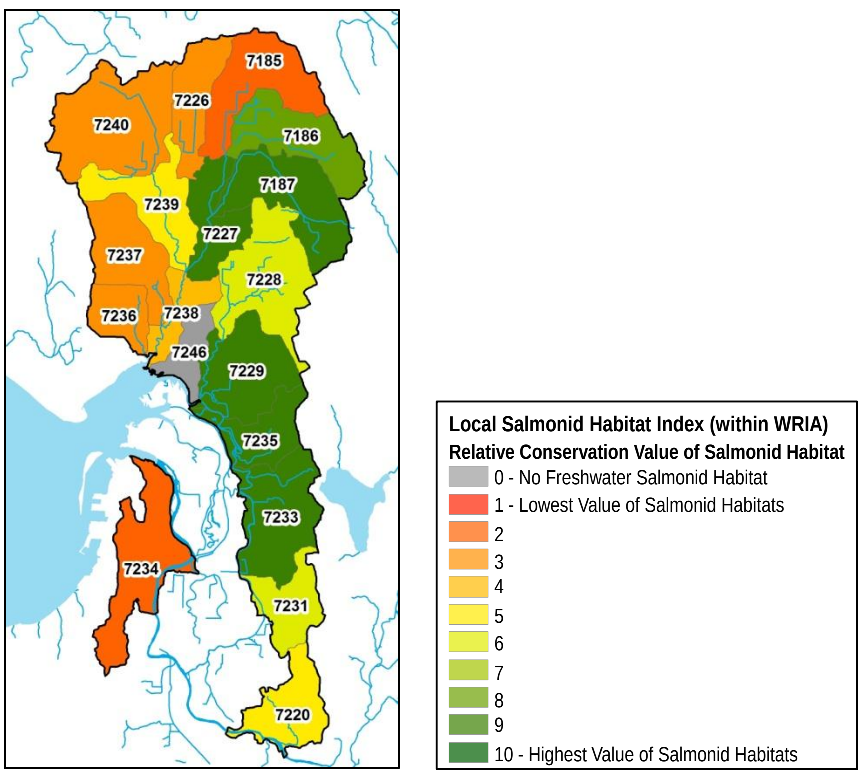



**Figure 48. Scale 1 results of the local salmonid habitat index (WHI) for the Estuary Drainages planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 23 and Figure 49 provide an integrated look at the assessments for Water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 47) and salmonid habitats (using scale 1 WRIA 7 results, Figure 48) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or limiting factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 23 below summarizes the scale 2 water flow recommendations for the Estuary drainages which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 23. Integration of assessment results for the Estuary Drainages planning unit to identify priority AUs.**

<table>
<tr><td>Water Flow Importance</td><td>Water Flow Degradation</td><td>Water Quality Results – Sediment</td><td>Local Salmonid Habitats</td><td colspan="2">Considerations</td></tr>
<tr><td rowspan="5">Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: Generally occur in the Quilceda and Allen creeks 7226, 7227, 7228, 7229, 7246</td><td rowspan="5">Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: generally occur in the Quilceda Creek and city of Everett – 7226, 7227, 7229, 7234, 7238, 7246</td><td rowspan="5">AUs meeting cutoff (top 25%) threshold: 7240</td><td rowspan="5">AUs meeting habitat value cutoff (deciles 8-10) threshold:<br>7186<br>7187<br>7227<br>7229<br>7233<br>7235</td><td colspan="2">Priority AUs based on integration:<br>Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>None</td><td>7226, 7227*, 7228, 7229*, 7246</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>No highest priority AUs have lower relative degradation in the planning unit.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. * Indicates high relative salmonid habitat value in AU.</td></tr>
<tr><td colspan="6">Basin Scale (2) considerations</td></tr>
<tr><td>Highest Ranked processes (from scale 2): surface storage, recharge, discharge</td><td>Highest Ranked processes (from scale 2): delivery, discharge, surface storage</td><td></td><td></td><td colspan="2"><u>Water flow:</u><br>Overall land use recommendation: Restoration<br><br>Priority water flow components to protect and restore: restoration of surface storage, recharge, and delivery</td></tr>
</table>

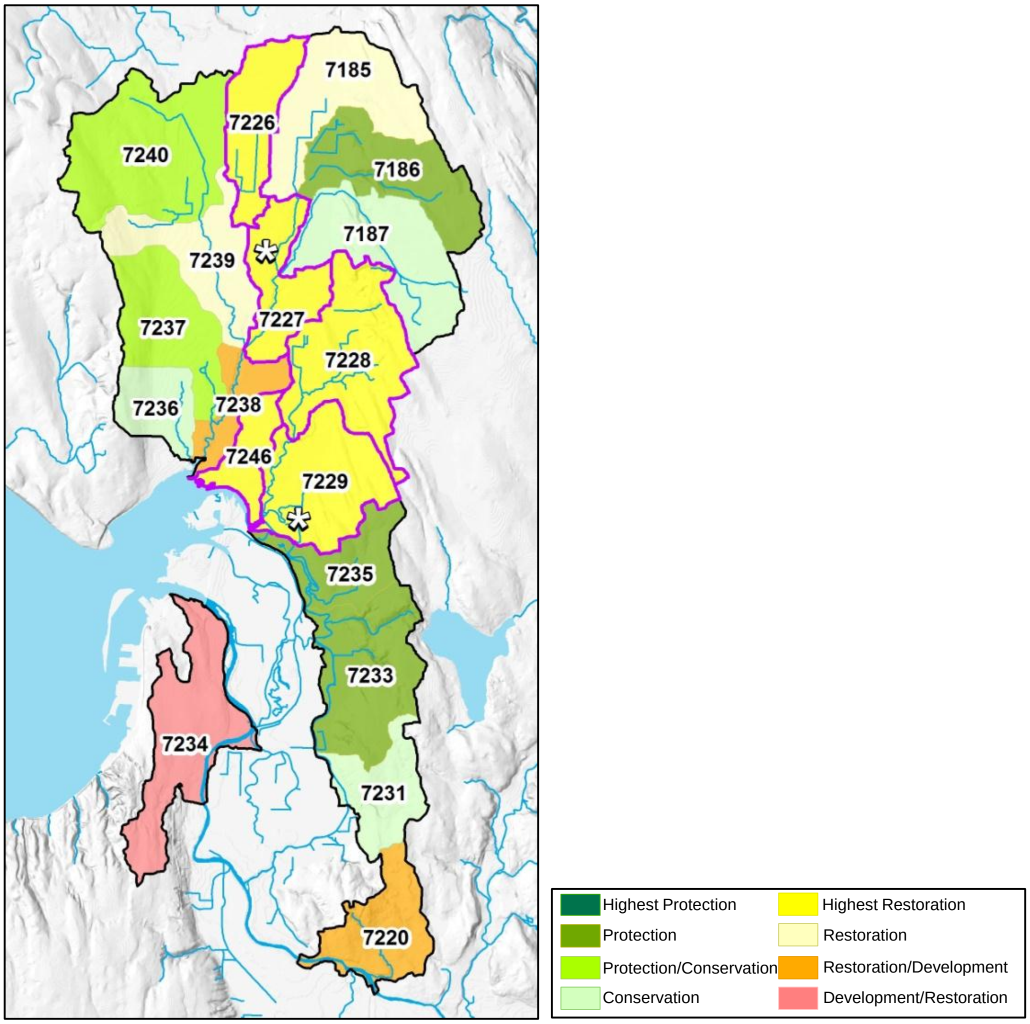



**Figure 49. Highest priority assessment units for protection of water flow processes in the Estuary Drainages planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats.

## Pilchuck River Planning Unit

The Pilchuck River Planning unit (Figure 50) is comprised of the entirety of the Pilchuck river from its headwater reaches to the confluence with the mainstem of the Snohomish river. In comparison to the rest of the Lower Snohomish basin (Figure 51), AUs in the Pilchuck River planning unit generally rank higher for importance to overall water flow processes and lower for degradation, though some areas of the lower watershed are significantly impacted by development. As such, the *general land use recommendation for the Pilchuck River Planning unit is Highest Protection in the Upper watershed, Protection & Restoration in the lower watershed.*

Using the scale 2 basin results (Figure 27) for the sub-components of the water flow assessment we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation. When assessing the upper and lower portion of the watershed individually to look for predominant areas of highest importance to specific water flow processes we can target the following:

*Upper watershed- Protection of recharge and delivery*
*Lower watershed- Restoration of surface storage and discharge*

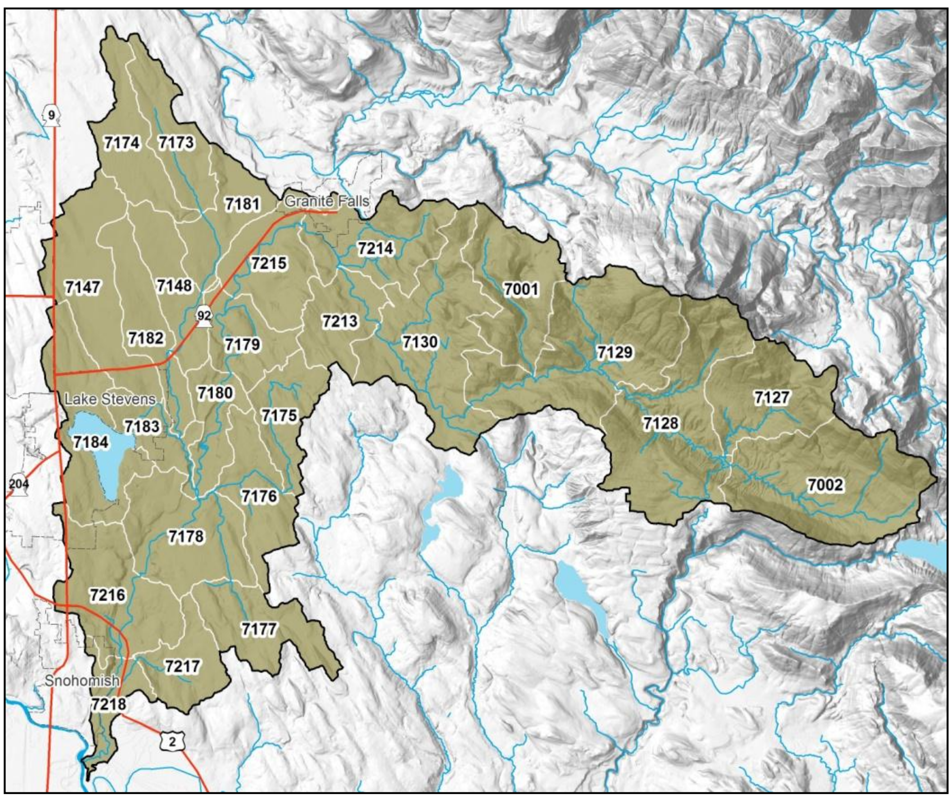



**Figure 50. The assessment units of the Pilchuck River planning unit.**

### Scale 3 water flow results

The scale 3 water flow assessment for the Pilchuck River planning unit (Figure 52) uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

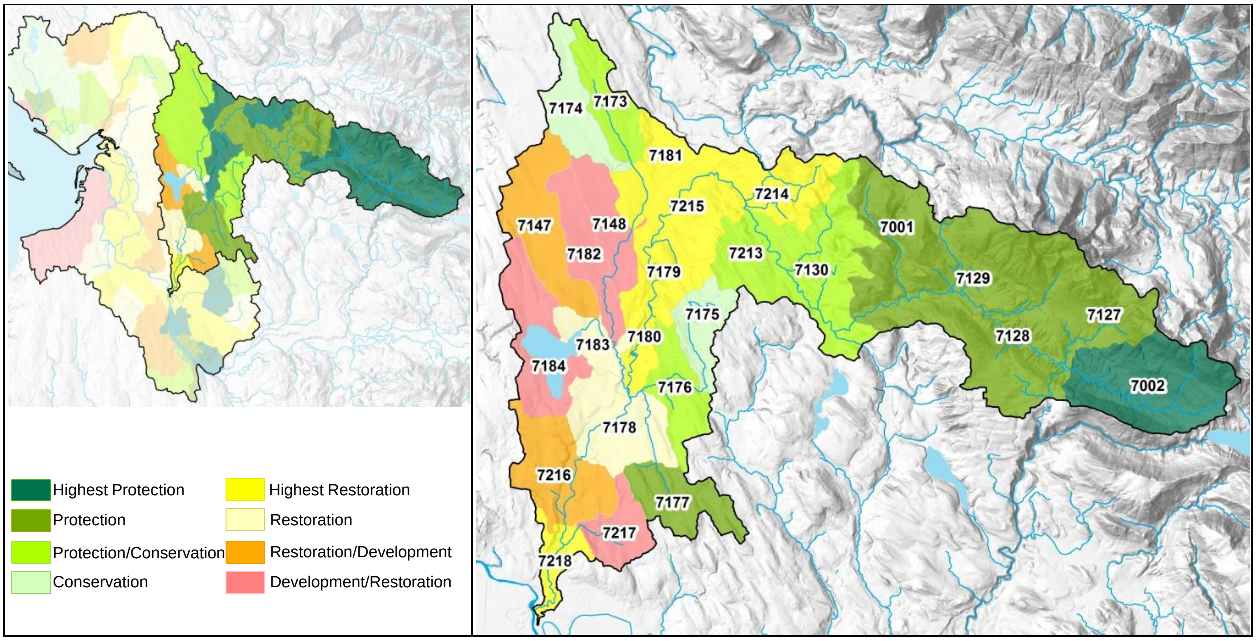



**Figure 51. The Scale 2 (left panel) and Scale 3 overall water flow Protection & Restoration results for the Pilchuck River planning unit.**

The scale 3 assessment results can be used to determine, specific to the Pilchuck River planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Pilchuck River planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs. The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. So, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

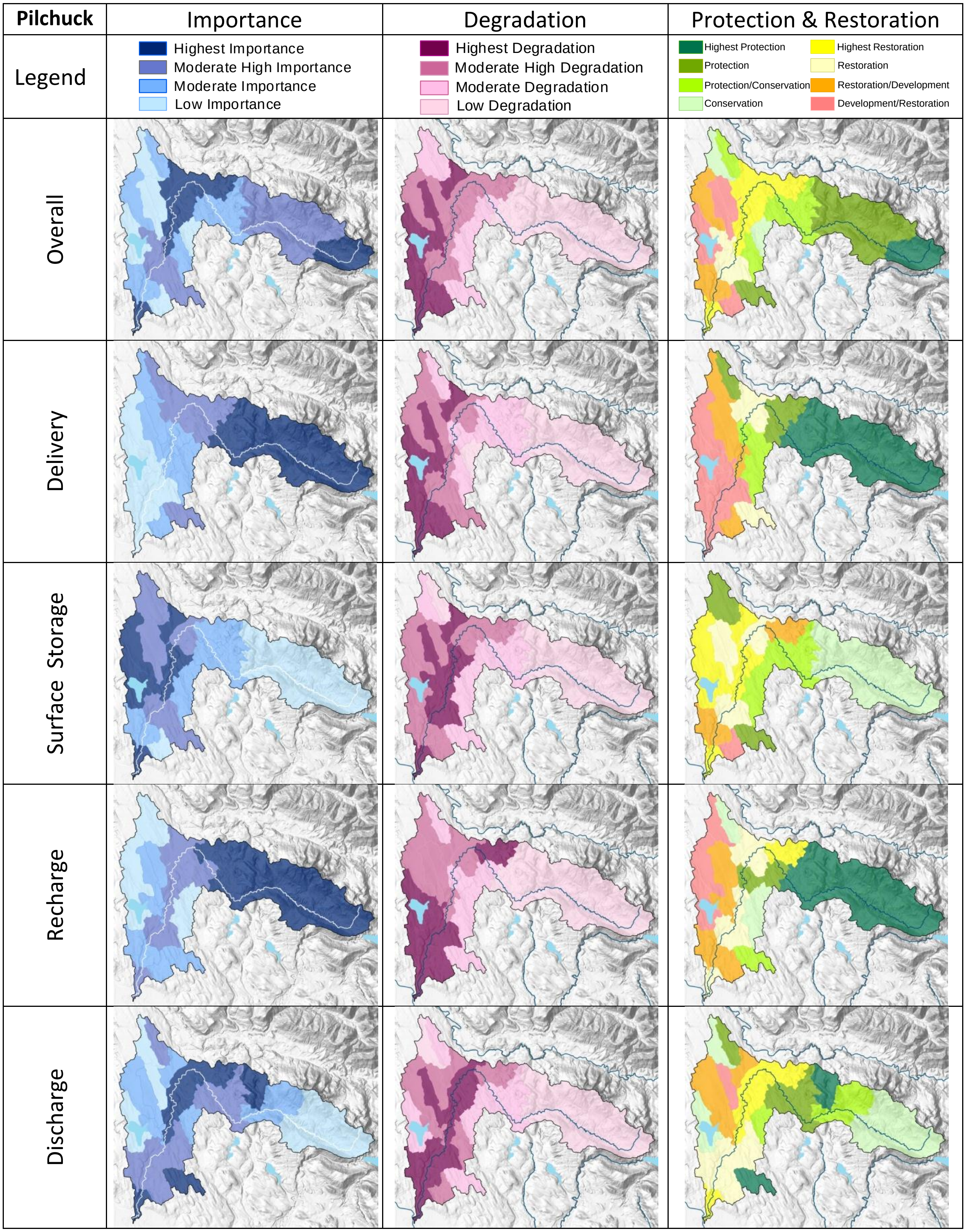



**Figure 52. Scale 3 water flow assessment results for the Pilchuck River planning unit.**

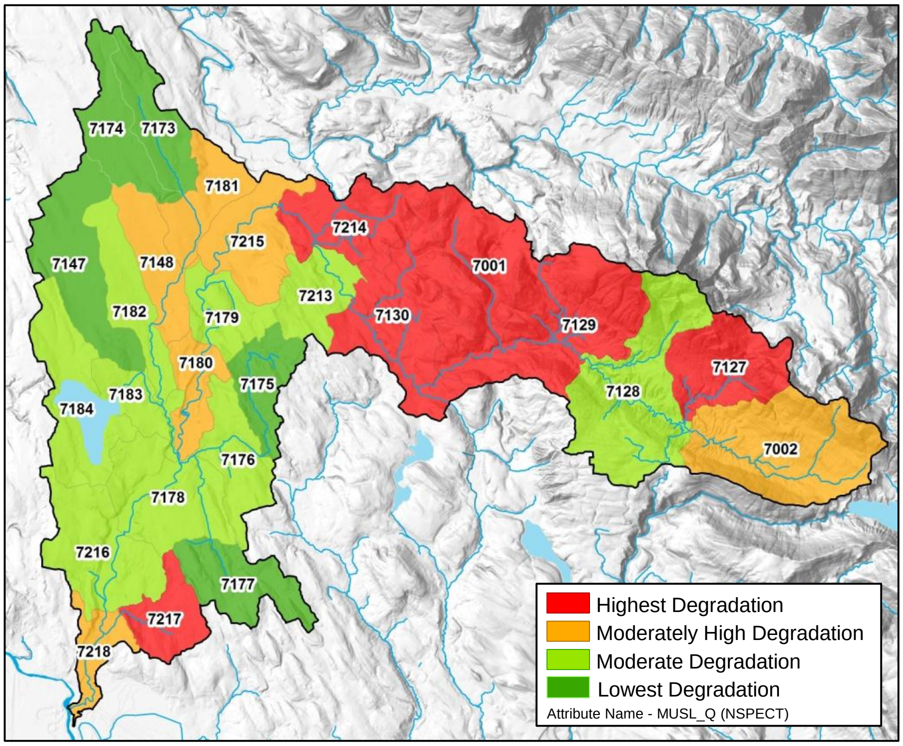



**Figure 53. Scale 1 results of sediment process degradation for the Pilchuck River planning unit.**

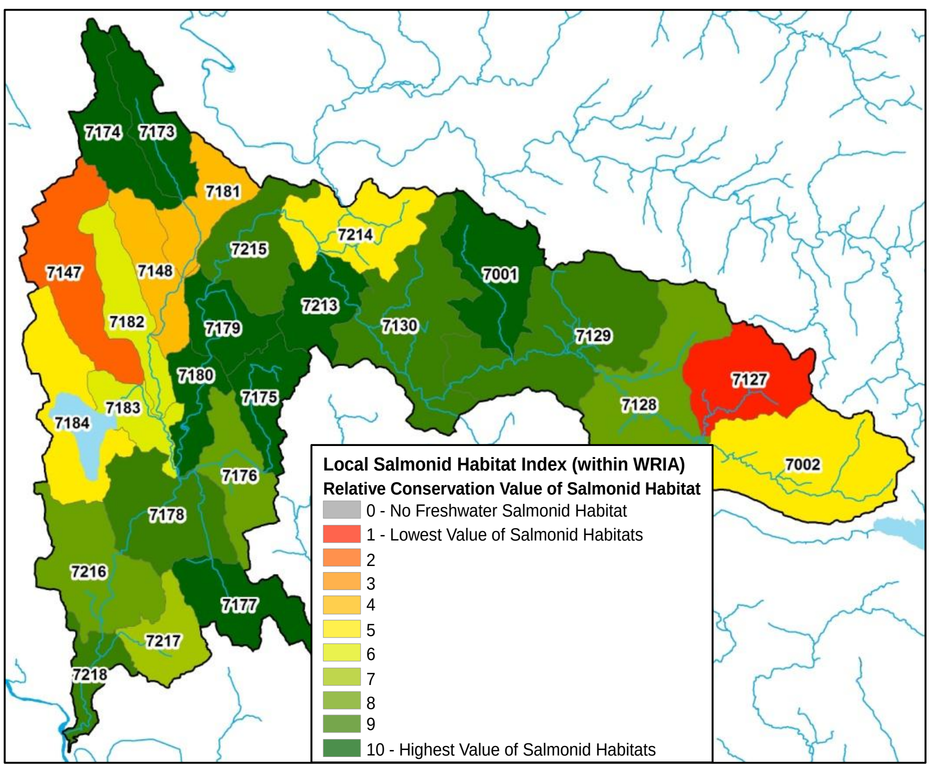



**Figure 54. Scale 1 results ot the local salmonid habitat index (WHI) for the Pilchuck River planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 24 and Figure 55 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 53) and salmonid habitats (WRIA 7 results, Figure 54) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or factors that may hinder efforts based on the assessments of local salmonid habitat value and sediment process degradation.

Additionally, Table 24 below brings in the scale 2 water flow recommendations for the Pilchuck River which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 24. Integration of assessment results for the Pilchuck River planning unit to identify priority AUs.**

<table>
<tr><td>Water Flow Importance</td><td>Water Flow Degradation</td><td>Water Quality Results – Sediment</td><td>Local Salmonid Habitats</td><td colspan="2">Considerations</td></tr>
<tr><td rowspan="5">Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: 7002, 7179, 7180, 7181, 7214, 7215, 7218</td><td rowspan="5">Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: 7181, 7182, 7183, 7184, 7216, 7217, 7218</td><td rowspan="5">AUs meeting cutoff (top 25%) threshold: 7217, 7214, 7130, 7001, 7129, 7127</td><td rowspan="5">AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7001, 7128, 7129 7130, 7173, 7174 7175, 7176, 7177 7178, 7179, 7180 7213, 7215, 7216 7218</td><td colspan="2">Priority AUs based on integration:<br>Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>7002</td><td>7179*, 7181, 7180*, 7218*, (-)7214, 7215*</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs for overall water flow processes with lower levels of degradation.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation. No AUs with highest relative sediment degradation. (-) indicates significant sediment degradation could impact salmonid habitat protection efforts. * Indicates high relative salmonid habitat value in AU.</td></tr>
<tr><td colspan="6">Basin Scale (2) considerations</td></tr>
<tr><td>Highest Ranked processes: surface storage, Recharg, discharge, delivery</td><td>Highest Ranked processes: surface storage and discharge in the lower wateshed</td><td></td><td></td><td colspan="2"><u>Water flow:</u><br>Overall land use recommendation: Highest Protection in the Upper watershed, Protection & Restoration in the lower watershed<br><br>Priority water flow components to protect and restore: Protection of recharge and delivery in the upper watershed, restoration of discharge and surface storage in the lower watershed</td></tr>
</table>

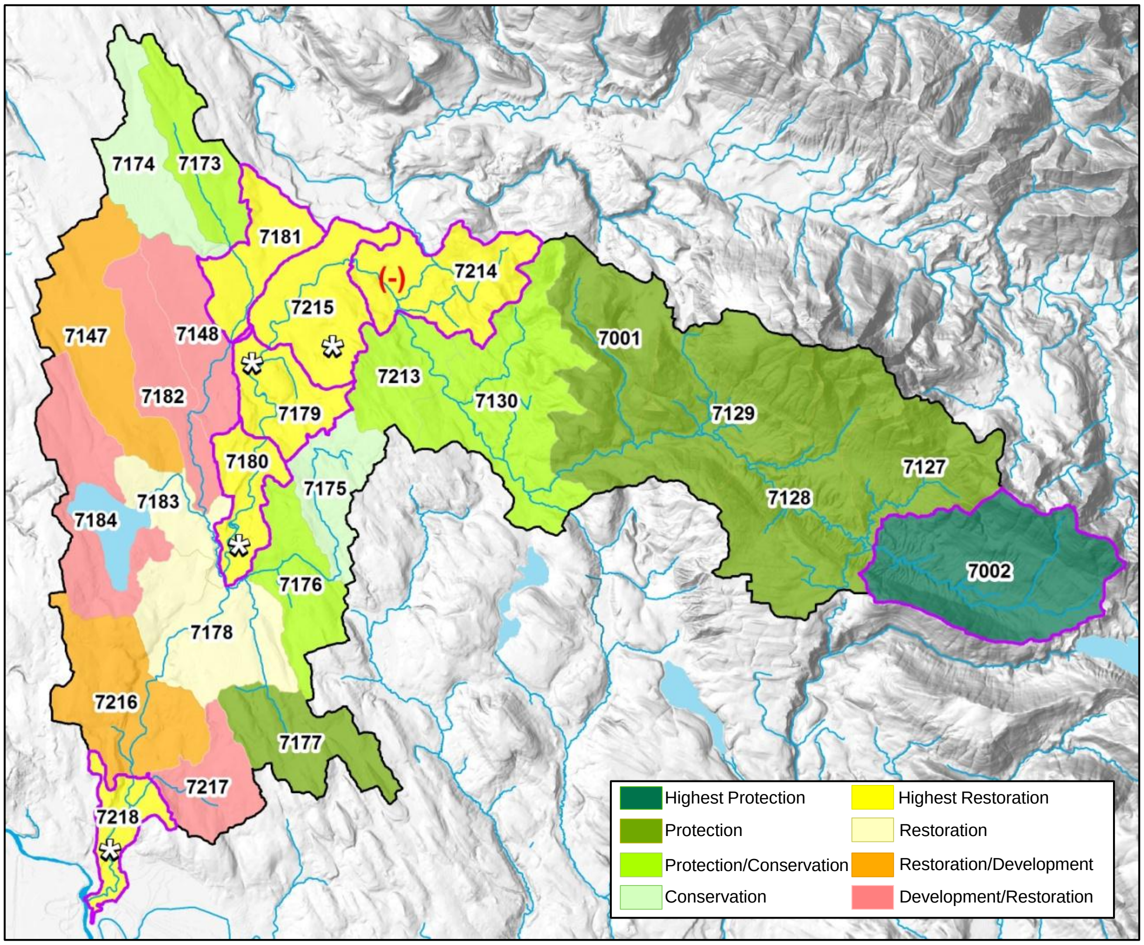



**Figure 55. Highest priority assessment units for protection of water flow processes in the Pilchuck River planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradatio

# Snoqualmie Basin Planning Units

## Lowland Mid-Snoqualmie Planning Unit

The Lowland Mid-Snoqualmie Planning unit is comprised of two watersheds (Figure 56), Patterson Creek and Cherry Creek, which flow into the mainstem Snoqualmie River. The Lowland Snoqualmie planning unit ranks last for importance to overall water flow processes and second highest for degradation to overall water flow processes when compared to the rest of the Snoqualmie basin (Table 14 & Figure 31) planning units. The general land use recommendation for the planning unit is best described for the individual watersheds given the disconnected nature and differences in overall degradation to water flow processes across these watersheds:

Cherry Creek- *Conservation & Development*
Patterson Creek- *Development & Restoration*

Using the scale 2 results for the sub-components of the water flow process (Figure 31) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation scores. When assessing the Lowland Mid-Snoqualmie planning unit to look for predominant areas of highest importance to specific water flow processes we can target the following:

Cherry Creek- *Restoration of discharge and surface storage processes*
Patterson Creek- *Restoration of discharge and surface storage processes*

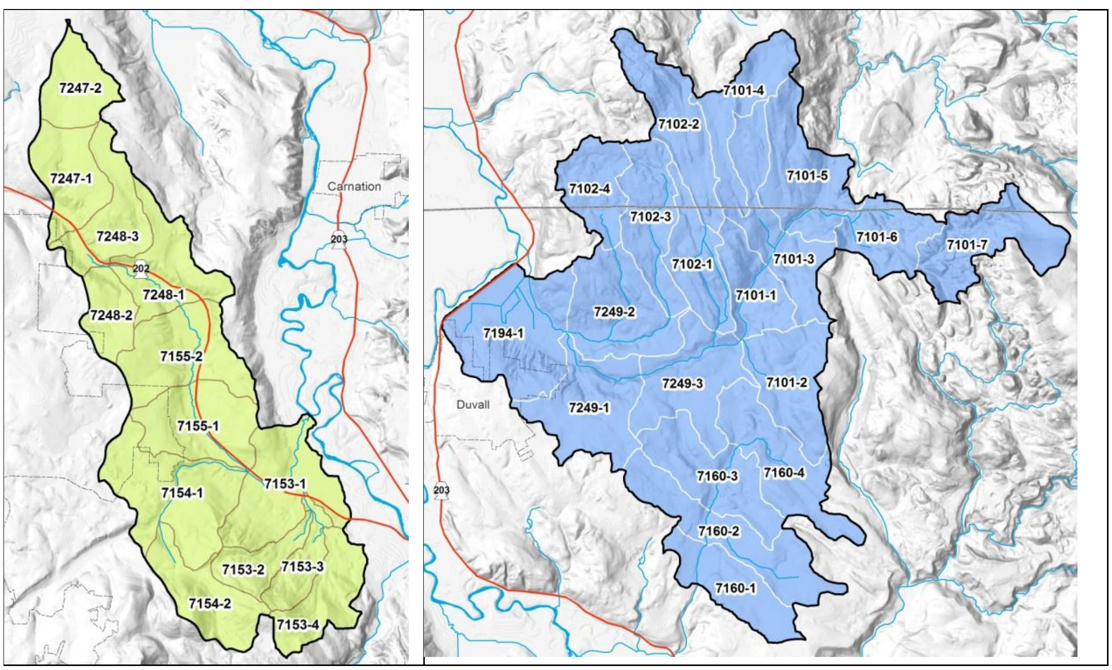



**Figure 56. The assessment units of the Lowland Mid-Snoqualmie planning unit,** comprised of Patterson (left panel), Cherry and Harris Creek (right panel) drainages.

**Scale 3 water flow results**

The Lowland Mid-Snoqualmie planning unit (scale 3) is a Type II delineation for the water flow results. New AUs were delineated given the small relative size of the planning unit. These new AUs are smaller to allow for a finer scale comparison within the planning unit to identify high priority areas for water flow processes. Given the different delineation, these scale 3 results (Figure 58 & 59) are based upon different raw values than those for the Type I AUs. In the case of the Lowland Mid-Snoqualmie planning unit, with the two separate and disconnected watersheds, it was determined that the scale 3 assessment would compare the Type II AUs only within each individual drainage (e.g. Patterson or Cherry Creeks). As such, relative scores from the scale 3 assessment are not directly comparable across the Patterson or Cherry Creek drainages.

To make comparisons across drainages the scale 2 results should be used (Figure 57). Note that the sediment process degradation and local salmonid habitats assessments for scale 3 do not use the Type II delineations. As such, when identifying AUs most important to water flow in this planning unit, and linking them to those important for sediment or salmonid habitats, the relationship is not direct. Those areas in a watershed which may account for the AU's score using the sediment or habitat results cannot be directly attributed to the same areas in the smaller, Type II AUs used to score water flow processes. Additionally, recall that the sediment and local salmonid habitat results are those from the WRIA 7 scale assessment (Figure 60 & 61).

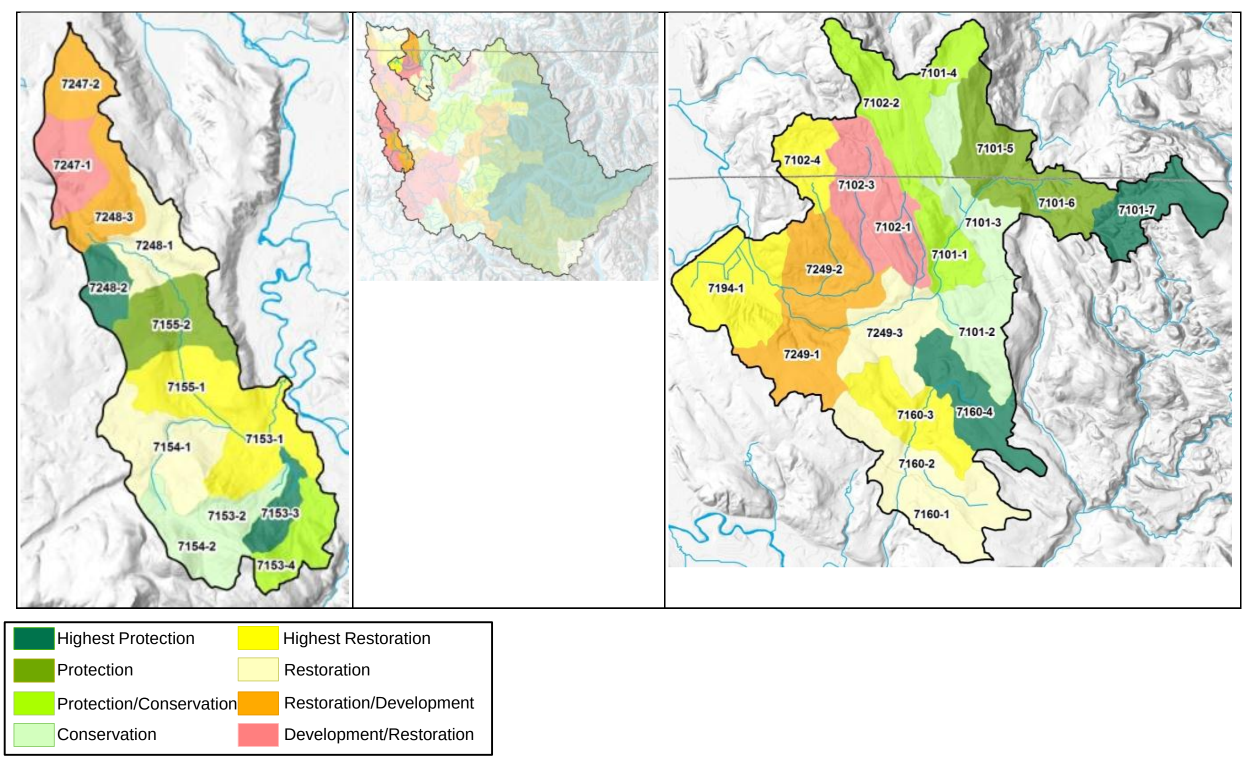



**Figure 57. The scale 2 (center panel) and scale 3 (right and left panels) overall water flow Protection & Restoration results for the Lowland Mid-Snoqualmie planning unit.**

The scale 3 assessment results can be used to determine, specific to the Lowland Mid-Snoqualmie planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Lowland Mid-Snoqualmie planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs. The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As a result, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

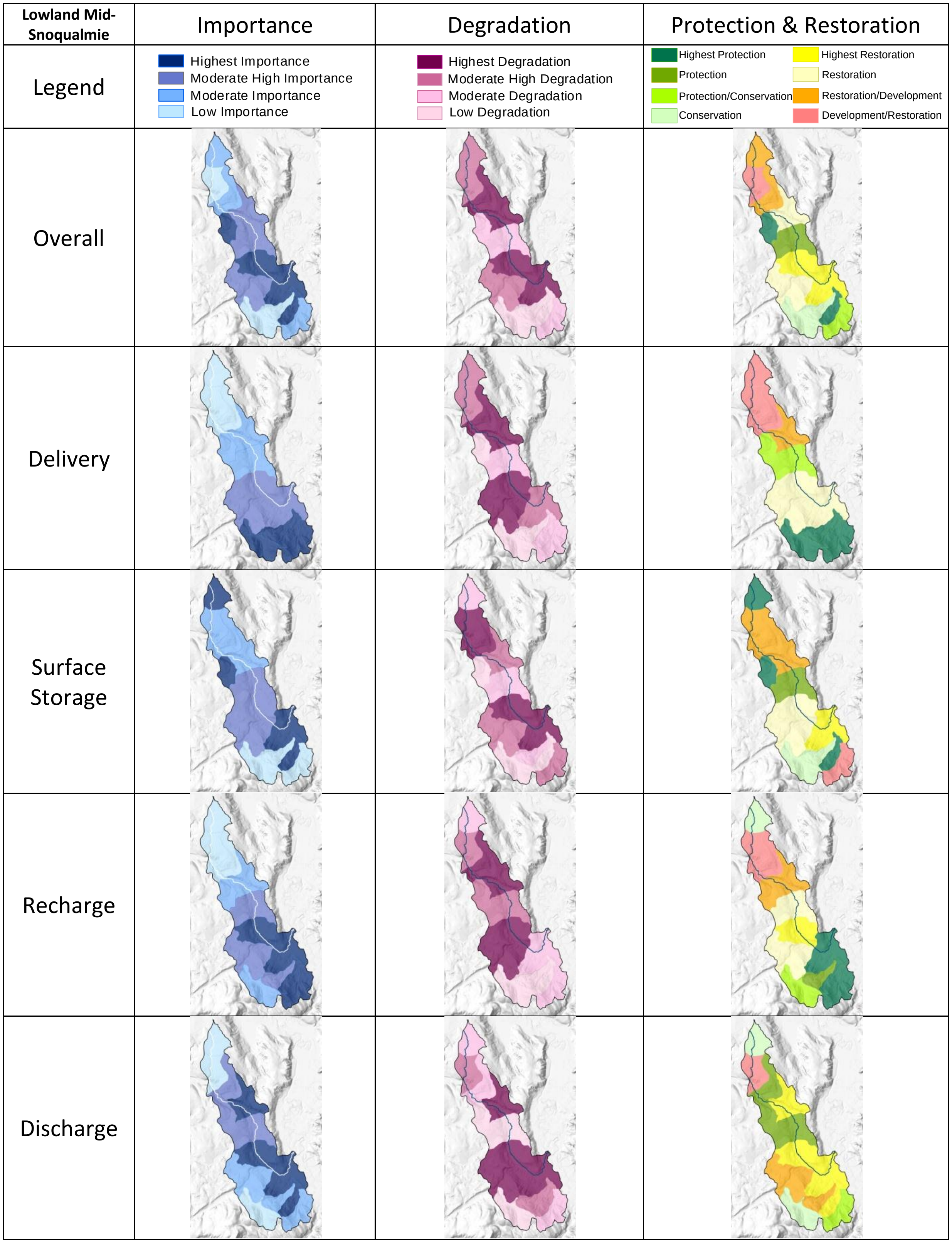



**Figure 58. Scale 3 water flow assessment results for Patterson Creek.**

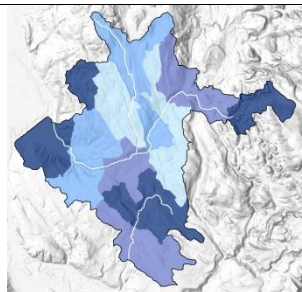
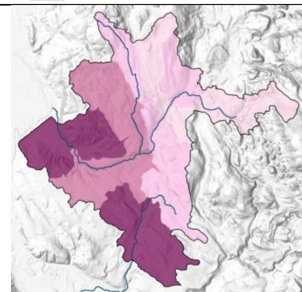
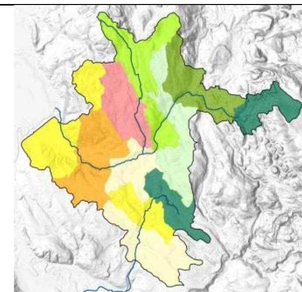
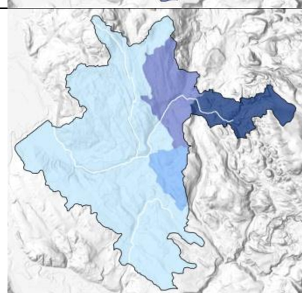
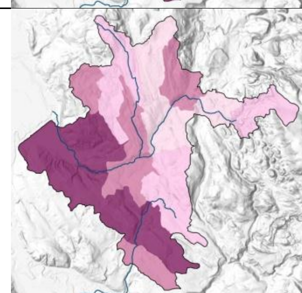
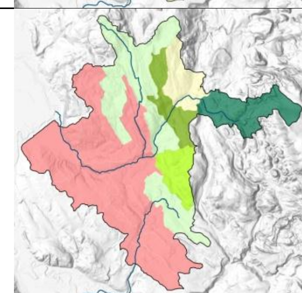
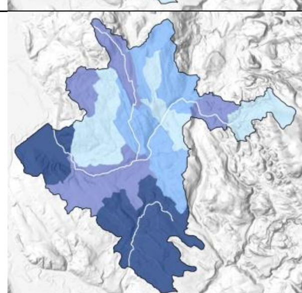
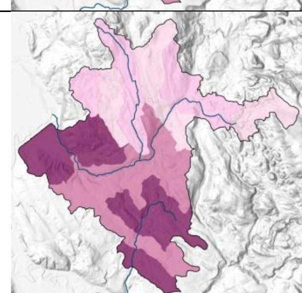
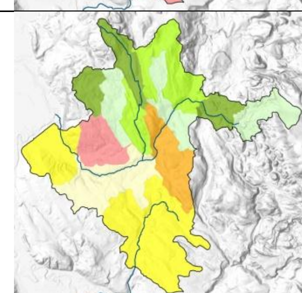
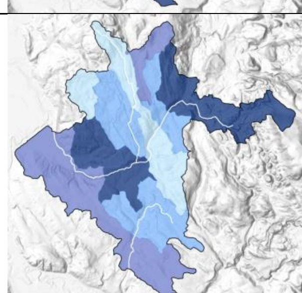
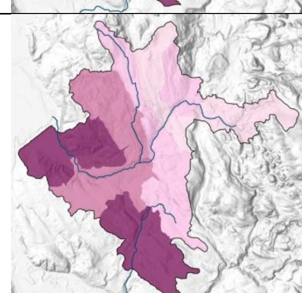
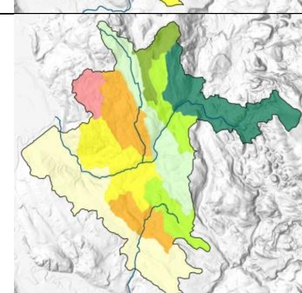
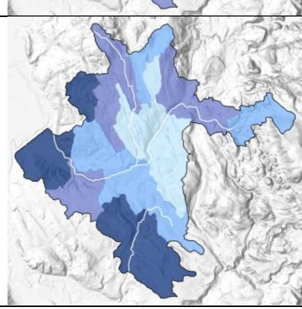
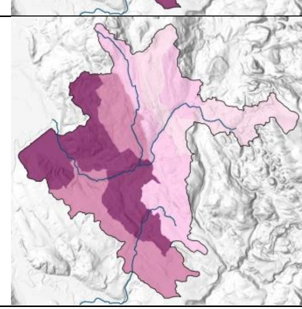
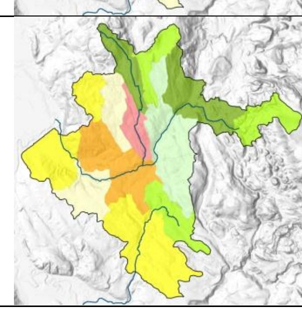
| Lowland Mid-Snoqualmie | Importance | Degradation | Protection & Restoration |
|---|---|---|---|
| Legend | Highest Importance<br>Moderate High Importance<br>Moderate Importance<br>Low Importance | Highest Degradation<br>Moderate High Degradation<br>Moderate Degradation<br>Low Degradation | Highest Protection<br>Protection<br>Protection/Conservation<br>Conservation<br>Highest Restoration<br>Restoration<br>Restoration/Development<br>Development/Restoration |
| Overall |  |  |  |
| Delivery |  |  |  |
| Surface Storage |  |  |  |
| Recharge |  |  |  |
| Discharge |  |  |  |

**Figure 59. Scale 3 water flow assessment results for Cherry Creek.**

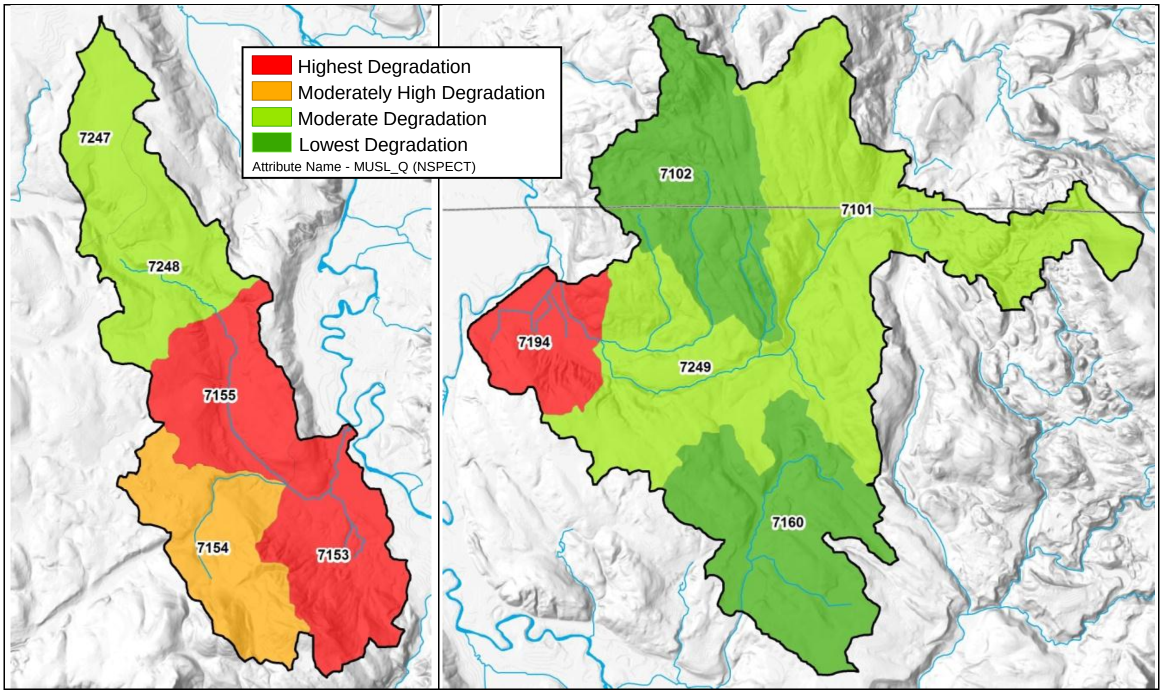



**Figure 60. Scale 1 results of sediment process degradation for the both Patterson Creek (left) and Cherry Creek (right) subbasins in the Lowland Mid Snoqualmie planning unit.**

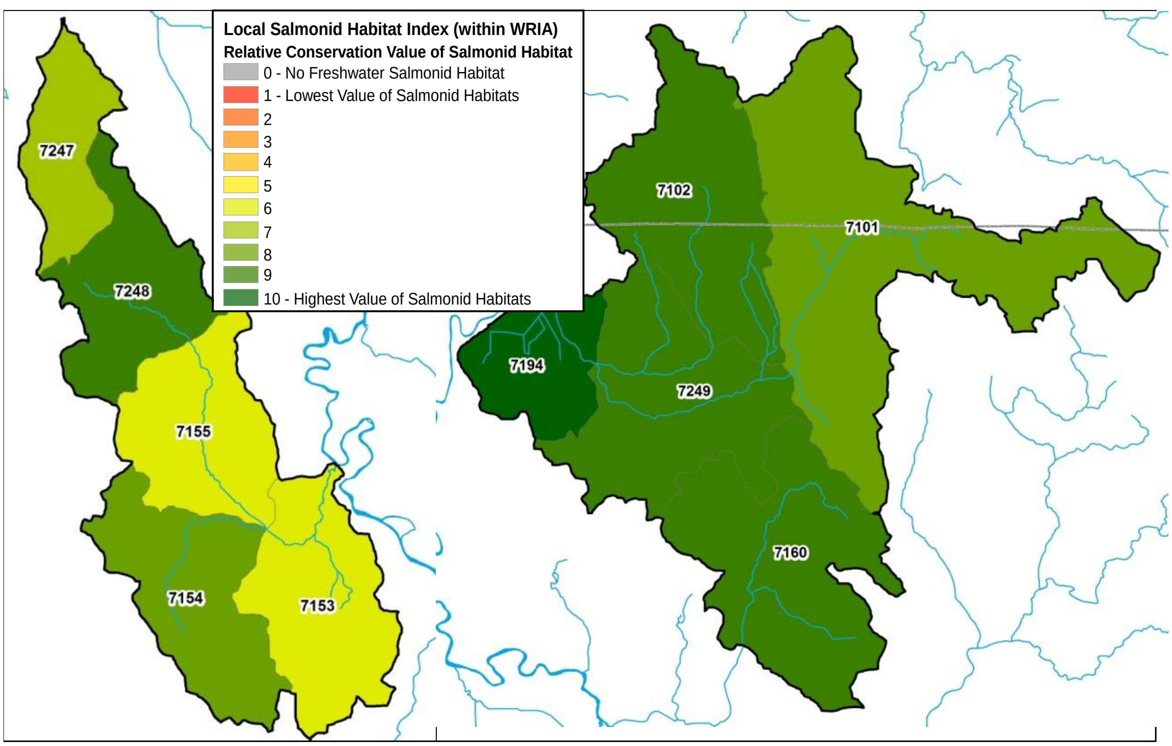



**Figure 61. Scale 1 results of the local salmonid habitat index (WHI) for both Cherry (right panel) and Patterson (left panel) creek subbasins in the Lowland Mid Snoqualmie planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 25 and Figure 62 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 60) and salmonid habitats (using scale 1 WRIA 7 results, Figure 61) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits or may be accrued, or factors that may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 25 below brings in the scale 2 water flow recommendations for the Lower Mid-Snoqualmie which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 25. Integration of assessment results for the Lowland Mid-Snoqualmie planning unit to identify priority AUs.**

<table>
<tr><td>Water Flow Importance</td><td>Water Flow Degradation</td><td>Water Quality Results Sediment</td><td>Local Salmonid Habitats</td><td>Considerations</td></tr>
<tr>
<td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: Patterson Creek AUs 7248-2, 7155-1, 7153-1, 7153-3<br>Cherry Creek AUs 7101-7, 7160-4, 7160-3, 7194-1, 7102-4</td>
<td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow:Patterson Creek AUs 7248-3, 7248-1, 7155-1, 7153-1<br>Cherry Creek AUs 7194-1, 7249-2, 7160-3, 7160-2, 7160-1</td>
<td>AUs meeting cutoff (top 25%) threshold: 7155, 7153, 7194</td>
<td>AUs meeting habitat value cutoff (deciles 8-10) threshold: no AUs in Patterson Creek and all AUs in Cherry Creek subbasin (scores arranged highest to lowest):<br>7101<br>7102<br>7154<br>7160<br>7194<br>7248<br>7249</td>
<td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>Patterson (-)7153-3, 7248-2*; Cherry 7101-7*, 7160-4*</td><td>Patterson (-)7155-1, (-)7153-1; Cherry 7160-3*, (-)7194-1*, 7102-4*</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs for overall water flow processes with lower levels of degradation.<br>AUs with (-) indicate high potential for degraded sediment processes which could undermine protection of salmonid habitats. * Indicates high relative salmonid habitat value in AU.</td><td>Highest priority AUs for overall water flow processes with higher levels of degradation.<br>AUs with (-) indicate high potential for degraded sediment processes which could undermine protection of salmonid habitats. * Indicates high relative salmonid habitat value in AU.</td></tr>
</table>
</td>
</tr>
<tr><td colspan="5">Basin Scale (2) considerations which may apply</td></tr>
<tr>
<td>Highest ranked subcomponents: surface storage, discharge</td>
<td>Highest ranked (most degraded) subcomponents: discharge, recharge, surface storage</td>
<td></td>
<td></td>
<td><u>Water flow - Cherry Creek:</u><br>Overall land use recommendation: Conservation & Development<br>Priority WF processes to protect and restore: restoration of discharge and surface storage processes<br><u>Patterson Creek:</u><br>Overall land use recommendation Development & Restoration<br>Priority water flow processes to protect and restore: Restoration of discharge and surface storage processes</td>
</tr>
</table>

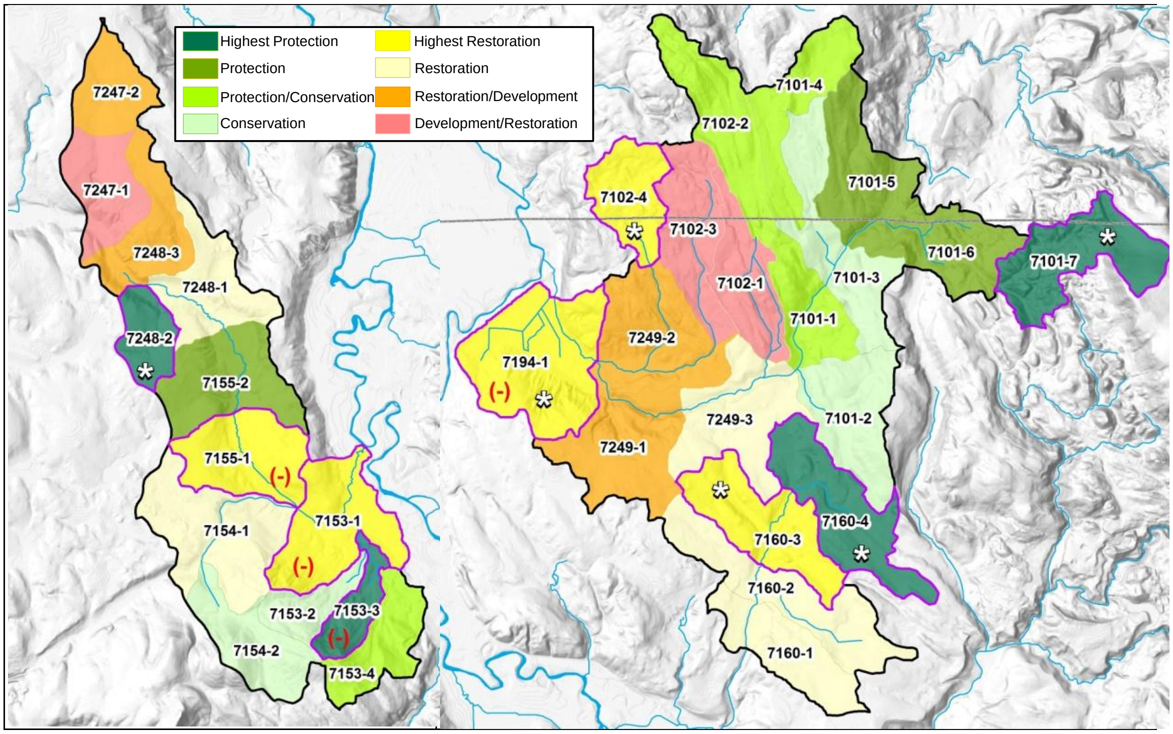



**Figure 62. Highest priority assessment units for protection of water flow processes in the Lower Mid-Snoqualmie planning unit.** Left panel Patterson Creek, Right panel Cherry Creek. Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## Tolt River Planning Unit

The Tolt River Planning unit is comprised of the North and South Forks (Figure 63) which combine to form the Tolt River which flows into the Snoqualmie near the town of Carnation. In comparison to the rest of the Snoqualmie basin (Table 14 and Figure 31), AUs in the Tolt River planning unit generally rank higher for importance to overall water flow processes and lower for degradation, though there are areas of higher relative degradation in the lower watershed. As such, *the general land use recommendation for the Tolt river is Protection & Restoration.*

Using the scale 2 results for the sub-components of the water flow process (Figure 31) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU’s relative importance and degradation.

Across the Tolt River planning unit, both the delivery and recharge exhibit predominant areas of highest ranked AUs for importance and lowest ranked AUs for degradation which indicate these may be considered priority processes to target protection efforts for water flow. Given the size of the Tolt River it may be helpful to target processes specific to one of the two major tributaries (North and South Forks) and the mainstem. When assessing each portion of the watershed individually to look for predominant areas of highest importance to specific water flow processes we can target the following:

North Fork- *Restoration of delivery processes, protection of recharge and discharge processes*
South Fork- *Protection and restoration of delivery and recharge processes*
Mainstem Tolt- *Protection and restoration of surface storage and discharge processes*

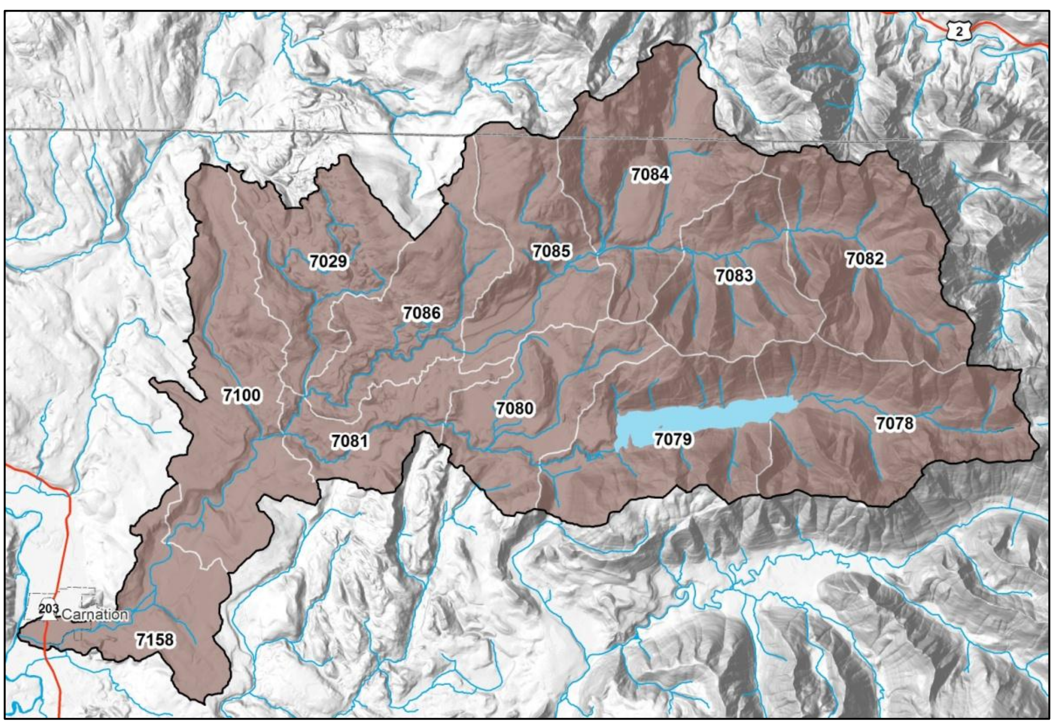



**Figure 63. The assessment units of the Tolt River planning unit.**

**Scale 3 water flow results**

The scale 3 water flow assessment (Figure 65) for the Tolt River planning unit used the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

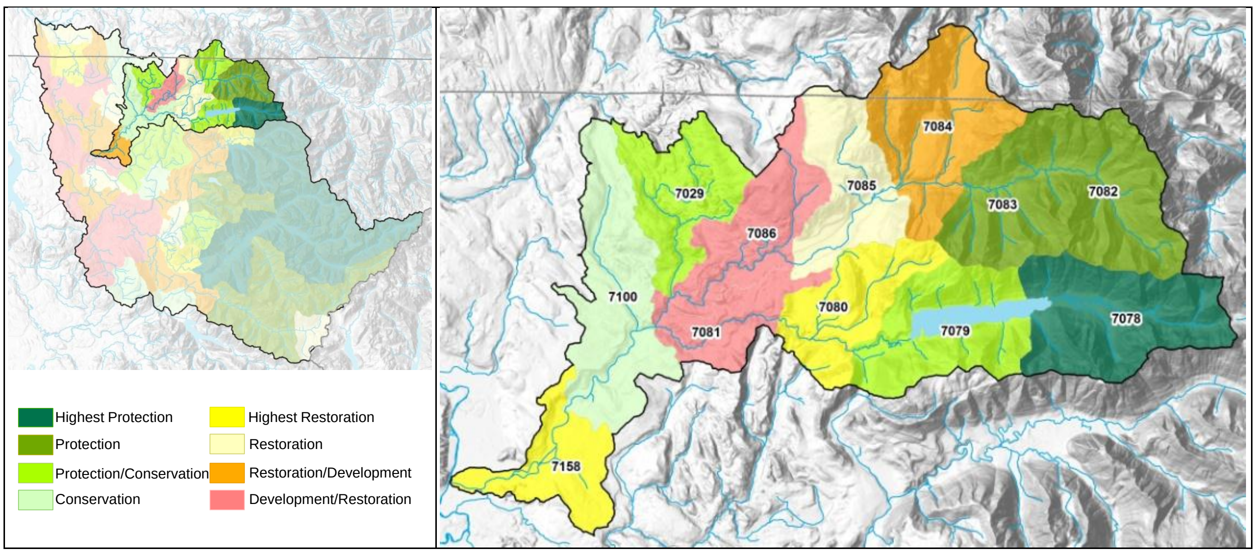



**Figure 64. The scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the Tolt River planning unit.**

The scale 3 assessment results can be used to determine, specific to the Tolt River planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Tolt River planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs (Figure 64). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. So, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

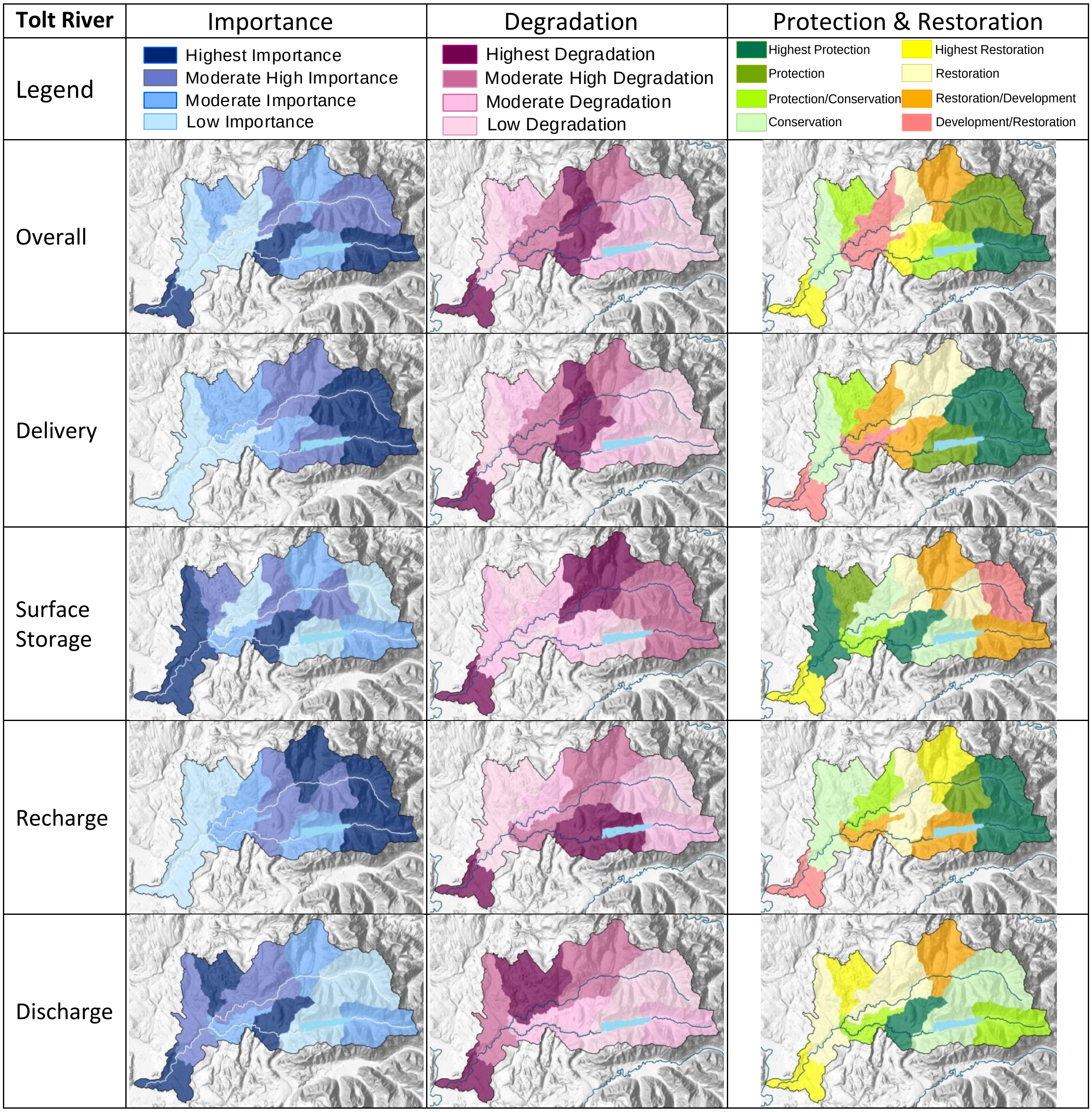



**Figure 65. Scale 3 water flow assessment results for the Tolt River planning unit.**

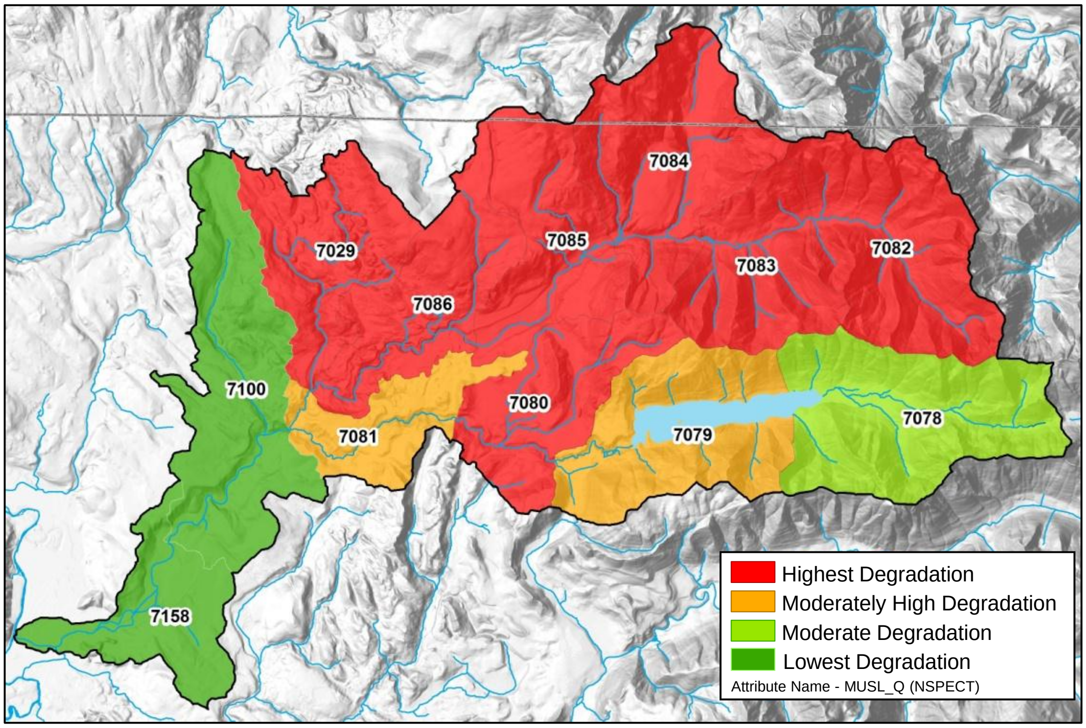



**Figure 66. Scale 1 results of sediment process degradation for the Tolt River planning unit.**

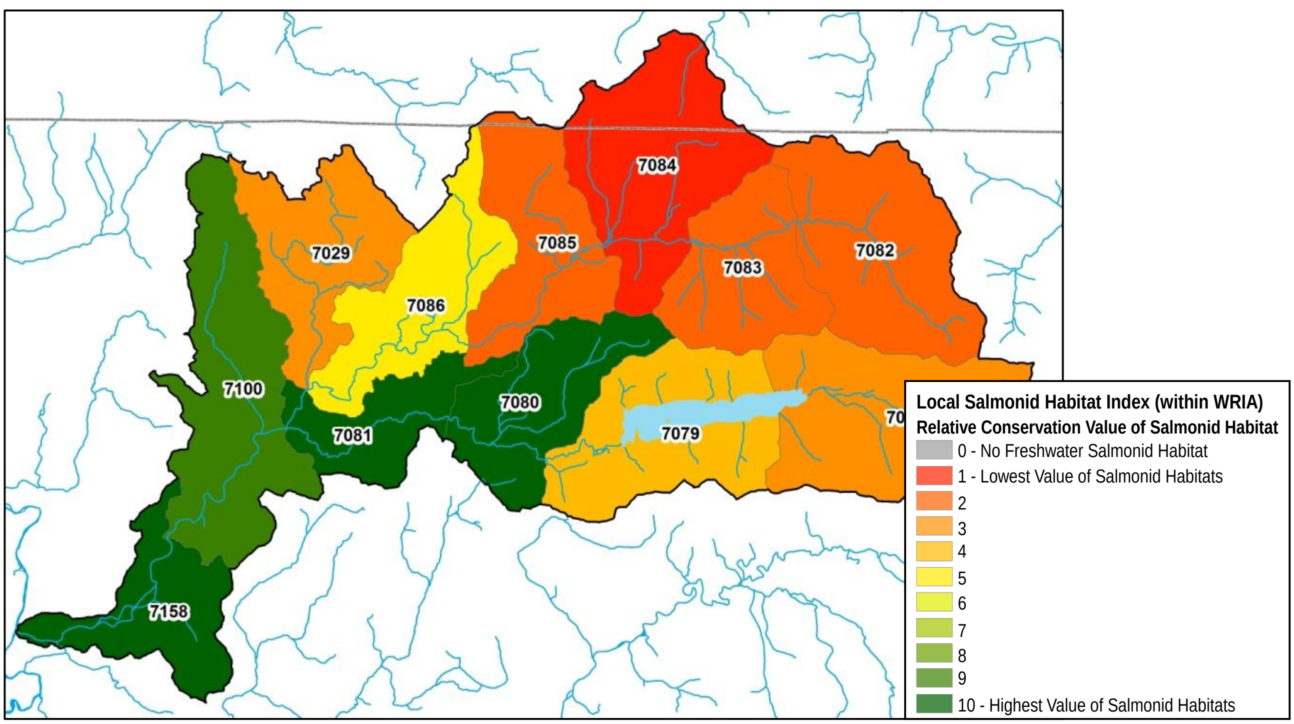



**Figure 67. Scale 1 results of the local salmonid habitat Index (WHI) for the Tolt River planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 26 and Figure 68 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 66) and salmonid habitats (using scale 1 WRIA 7 results, Figure 67) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or what factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 26 below brings in the scale 2 water flow recommendations for the Tolt River which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 26. Integration of assessment results for the Tolt River planning unit to identify priority AUs.**

<table>
<tr><th>Water Flow Importance</th><th>Water Flow Degradation</th><th>Water Quality Results – Sediment</th><th>Local Salmonid Habitats</th><th>Considerations</th></tr>
<tr>
<td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: 7078, 7080, 7158</td>
<td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: 7085, 7080, 7158</td>
<td>AUs meeting cutoff (top 25%) threshold: 7029, 7086, 7085, 7084, 7083, 7082, 7080</td>
<td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7080<br>7081<br>7100<br>7158</td>
<td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>7078</td><td>(-)7080*, 7158*</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs for overall water flow processes with lower levels of degradation.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation. AUs with (-) indicate sediment degradation may impact salmonid habitat protection.<br>* Indicates high relative salmonid habitat value in AU.</td></tr>
</table>
</td>
</tr>
<tr><td colspan="5" align="center">Basin Scale (2) considerations which may apply</td></tr>
<tr>
<td>Highest Ranked processes: surface storage near the mainstem Snoqualmie discharge, delivery</td>
<td>Highest Ranked processes: surface storage near the mainstem Snoqualmie, delivery is moderately high ranked.</td>
<td></td>
<td></td>
<td><u>Water flow</u><br>Overall land use recommendation: Protection & Restoration<br><br>Priority water flow processes to protect & restore:<br><u>North Fork</u>: Restoration of delivery processes, protection of recharge and discharge processes<br><u>South Fork</u>: Protection & restoration of delivery & recharge processes<br><u>Mainstem Tolt</u>: Protection and restoration of surface storage and discharge processes</td>
</tr>
</table>

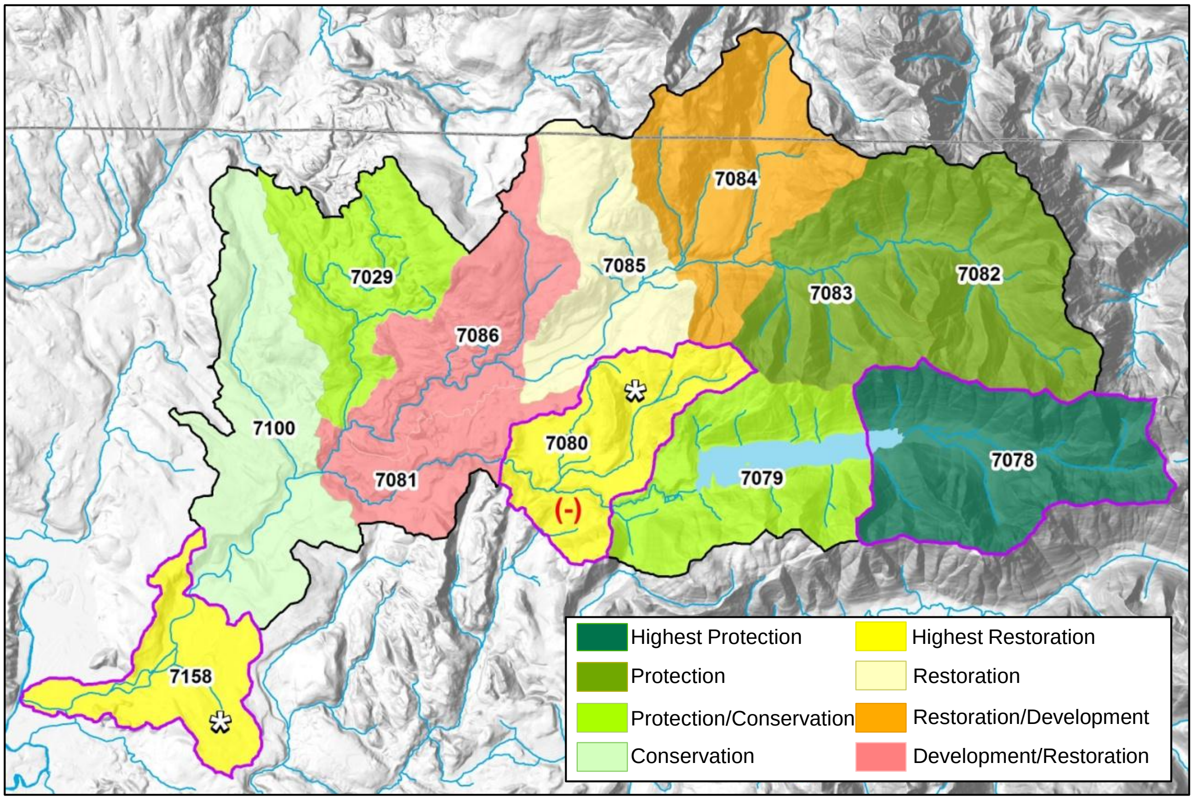



**Figure 68. Highest priority assessment units for protection of water flow processes in the Tolt River planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## Mid-Snoqualmie Planning Unit

The Mid-Snoqualmie planning unit (Figure 69) is comprised primarily of the Tokul and Griffin creek drainages which flow southward into the Snoqualmie River mainstem near the towns of Preston and Fall City. The Mid-Snoqualmie planning unit ranks fourth in the Snoqualmie basin (Table 14) for overall importance and fifth for overall degradation to water flow processes. As such the *general land use recommendation for the planning unit is Conservation & Development.*

Using the scale 2 results (Figure 31) for the sub-components of the water flow process we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation scores. When assessing the Mid-Snoqualmie planning unit for predominant areas of highest importance to specific water flow processes we can target the following:
*Protection and restoration of surface storage and discharge processes.*

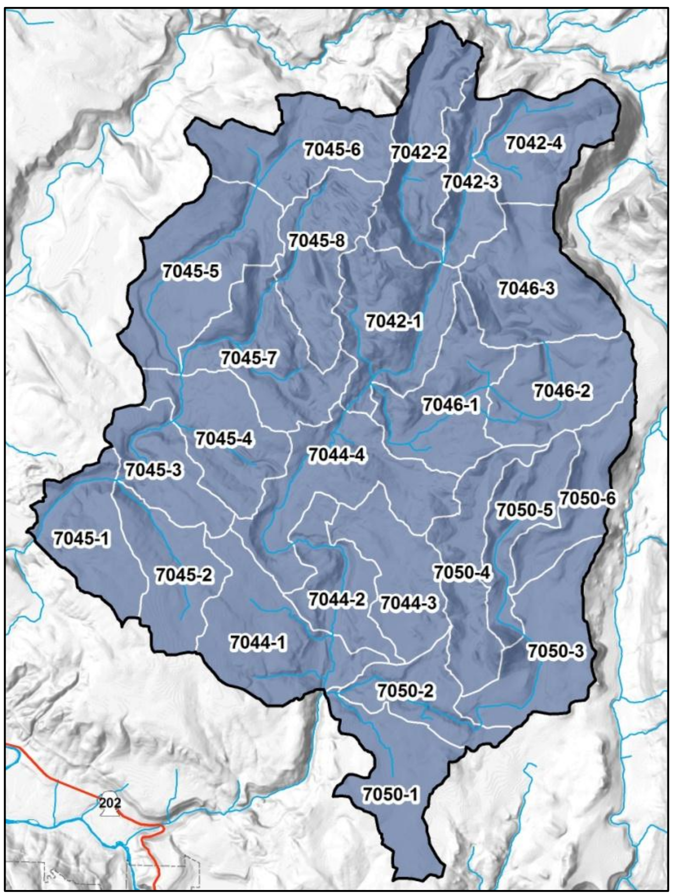



**Figure 69. The assessment units of the Mid-Snoqualmie planning unit.** The assessment units are Type II, indicating that they have been re-delineated for the water flow assessment at scale 3 to provide a greater range of comparisons.

**Scale 3 water flow results**

The Mid-Snoqualmie planning unit (scale 3) is a Type II delineation for the water flow results. New AUs were delineated given the small relative size of the planning unit. These new AUs are smaller to allow for a finer scale comparison within the planning unit to identify high priority areas for water flow processes.  Given the different delineation, these scale 3 results are based upon different raw values than those for the Type I AUs.  Note that the sediment degradation and local salmonid habitats assessments for scale 3 do not use the Type II delineations.  As such, when identifying AUs most important to water flow in this planning unit, and linking them to those important for sediment processes or salmonid habitats, the relationship is not direct.  Those areas in a watershed which may account for the AU's score using the sediment or Habitat results cannot be directly attributed to the same areas in the smaller, Type II AUs used to score water flow processes.  Additionally, recall that the sediment and local salmonid habitat results are those from the WRIA 7 scale assessment.

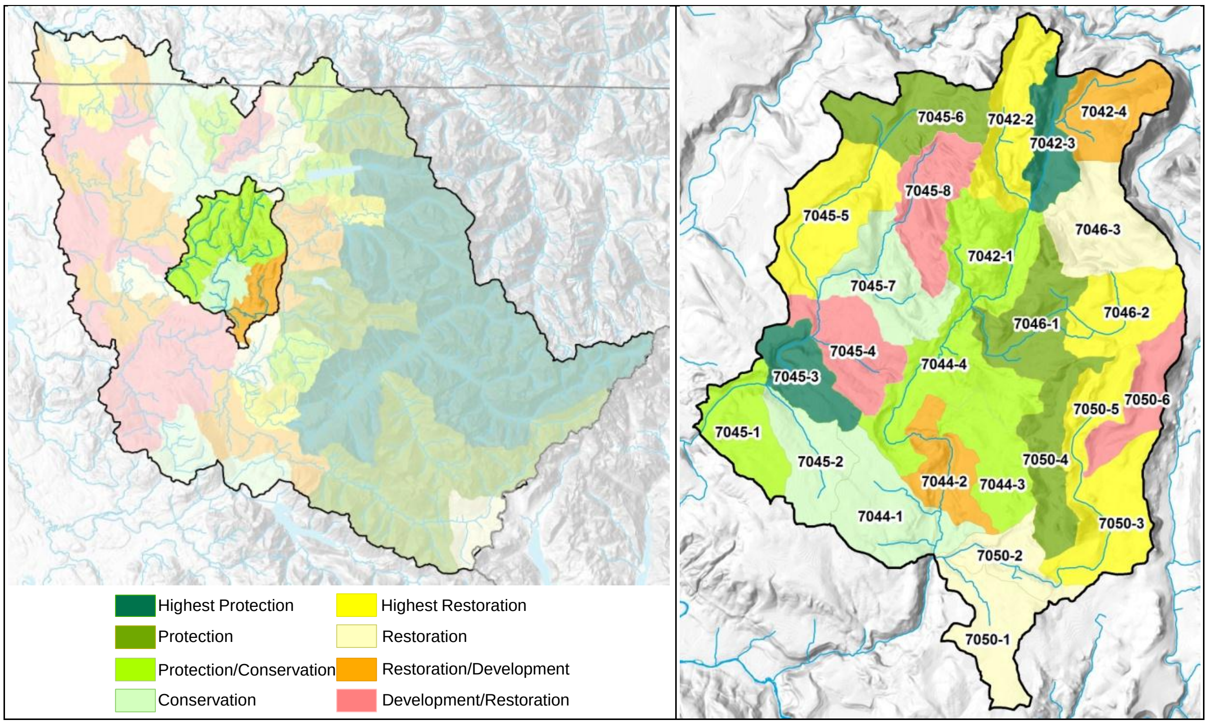



**Figure 70. The scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the Mid-Snoqualmie planning unit.**

The scale 3 assessment results (Figure 71) can be used to determine, specific to the Mid-Snoqualmie planning unit, *where* to focus protection actions for water flow processes.  If an entity is prioritizing protection actions in the Mid-Snoqualmie planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking.  If an entity is attempting to address specific components of the water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs (Figure 70). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As a result, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

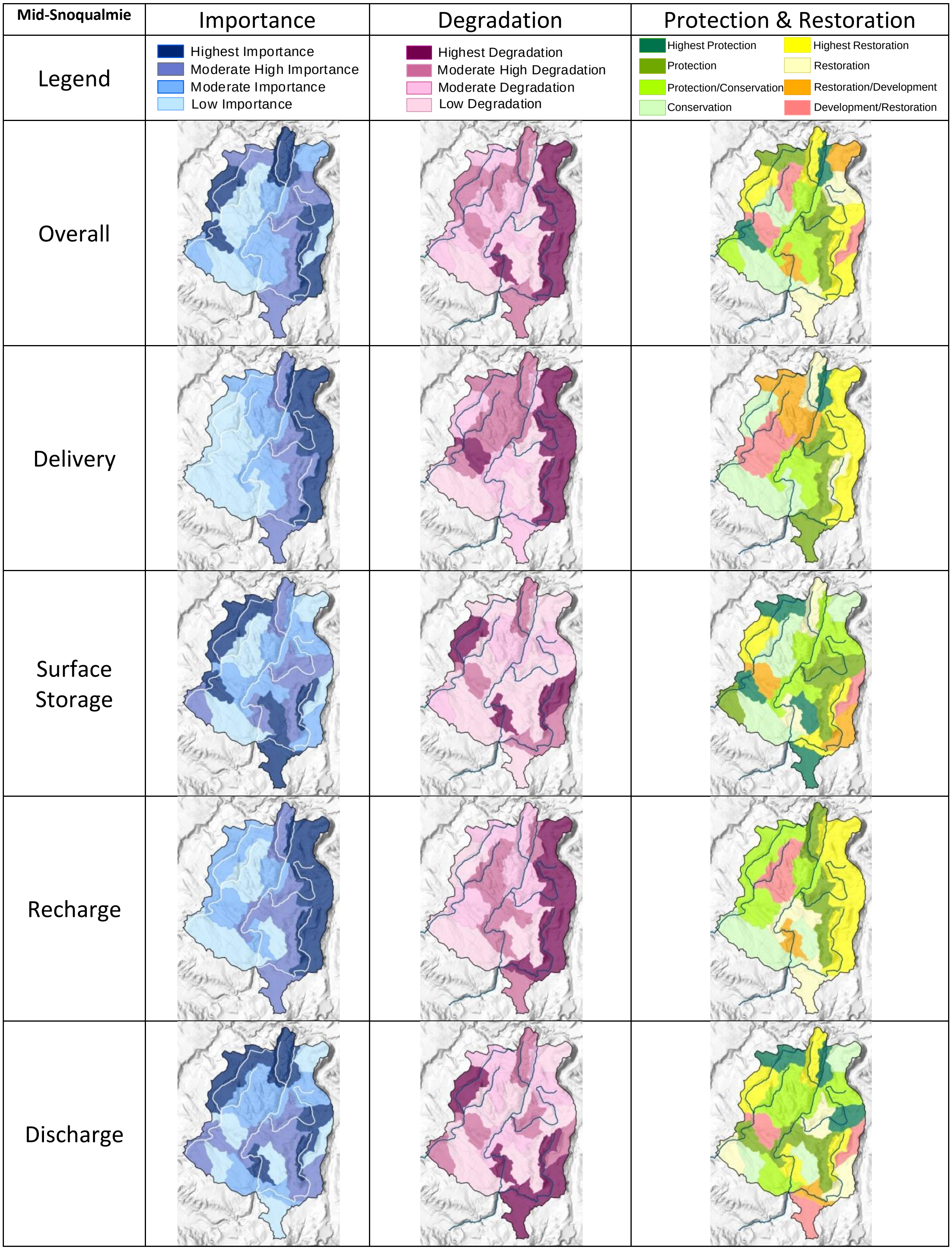



**Figure 71. Scale 3 water flow assessment results for the Mid-Snoqualmie planning unit.**

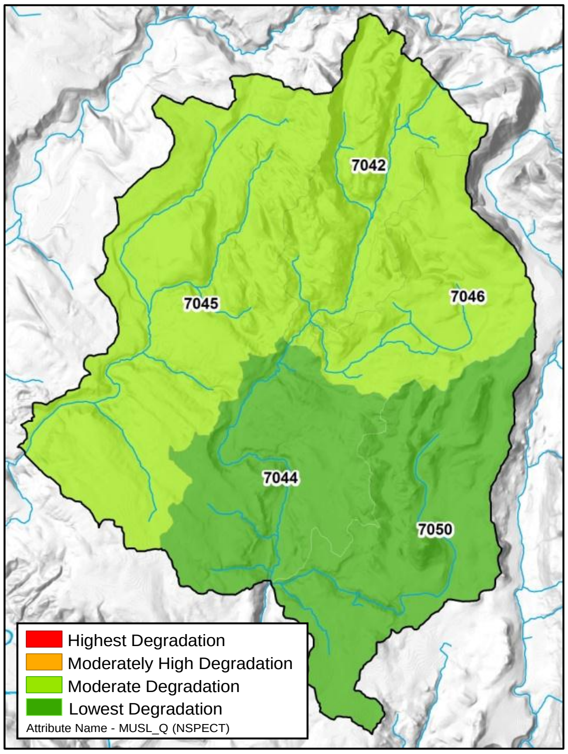



**Figure 72. Scale 1 results of sediment process degradation for the Mid-Snoqualmie planning unit.**

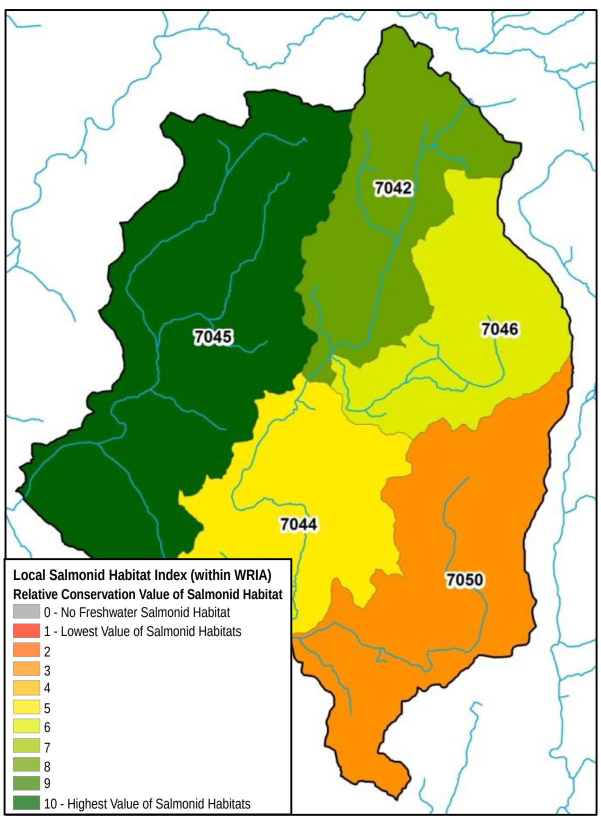



**Figure 73. Scale 1 results of the local salmonid habitat Index (WHI) for the Mid-Snoqualmie planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 27 and Figure 74 provides an integrated look at the assessments for Water flow (using scale 3 results), sediment degradation (using WRIA 7 results, Figure 72) and salmonid habitats (WRIA 7 results, Figure 73) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of w*here* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 27 below brings in the scale 2 water flow recommendations for the Mid-Snoqualmie planning unit which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 27. Integration of assessment results for the Mid-Snoqualmie planning unit to identify priority AUs.**

<table>
<tr><td>Water Flow Importance</td><td>Water Flow Degradation</td><td>Water Quality Results – Sediment</td><td>Local Salmonid Habitats</td><td>Considerations</td></tr>
<tr><td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: 7045-5, 7045-3, 7042-2, 7042-3, 7046-2, 7050-5, 7050-3,</td><td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow:7042-4, 7046-3, 7046-2, 7050-5, 7050-6, 7050-3, 7044-2</td><td>AUs meeting cutoff (top 25%) threshold: none</td><td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7042<br>7045</td><td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>7042-3*, 7045-3*</td><td>7042-2*, 7045-5*, 7046-2, 7050-5, 7050-3</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs for overall water flow processes with lower levels of degradation. * Indicates high relative salmonid habitat value in AU.</td><td>Highest priority AUs for overall water flow processes with higher levels of degradation. * Indicates high relative salmonid habitat value in AU.</td></tr>
</table></td></tr>
<tr><td colspan="5">Basin Scale (2) considerations which may apply</td></tr>
<tr><td>Highest ranked sub-components: surface storage and discharge</td><td>Highest ranked (most degraded)sub components: discharge,</td><td></td><td></td><td><u>Water flow</u><br>Overall land use recommendation: Conservation & Development<br><br>Priority water flow processes to protect and restore: Protection and restoration of surface storage and discharge</td></tr>
</table>

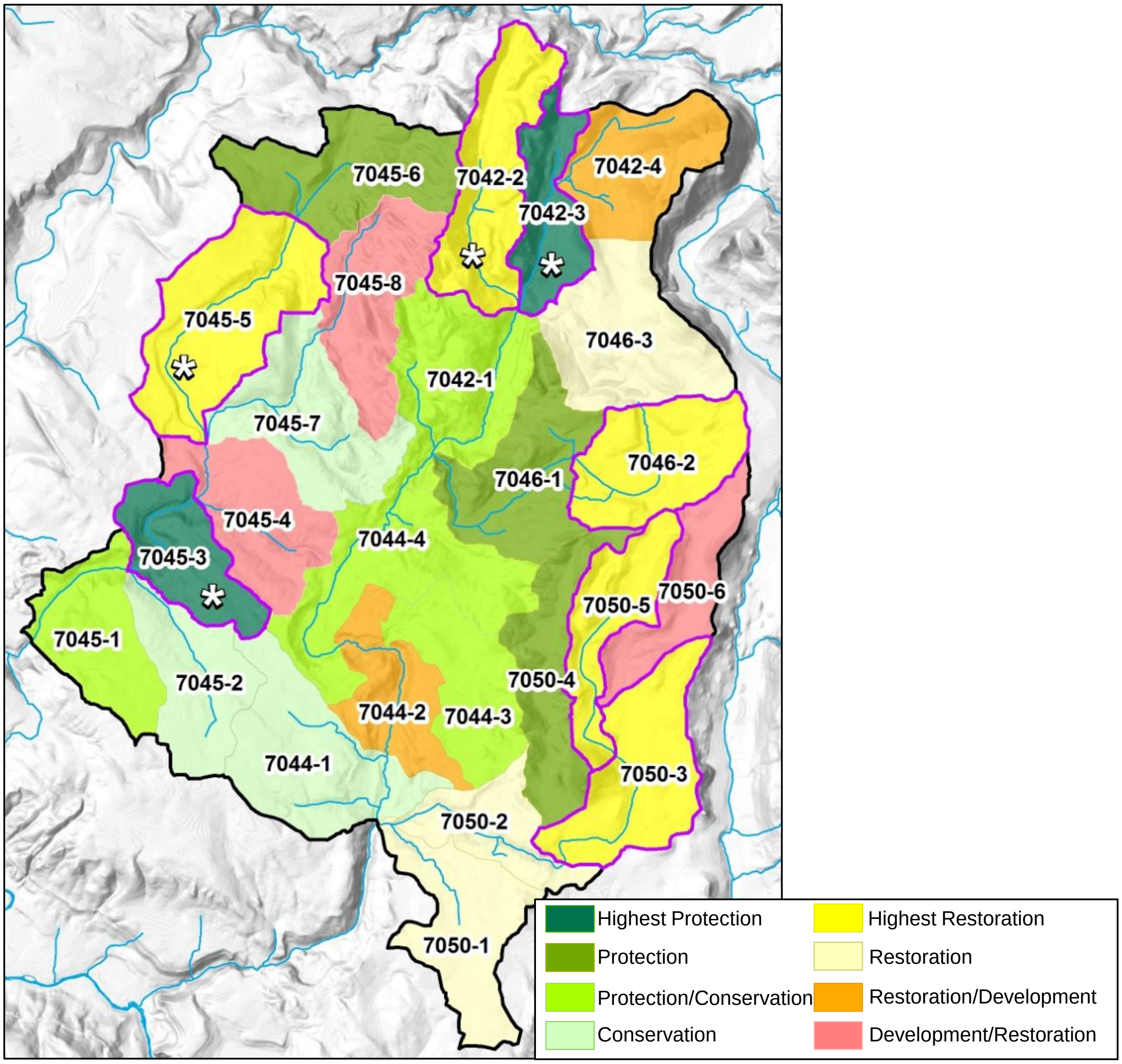



**Figure 74. Highest priority assessment units for protection of water flow processes in the Mid-Snoqualmie planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats.

## Raging River Planning unit

The Raging River planning unit is comprised of the Raging River, which flows into the Snoqualmie mainstem at Fall City (Figure 75). In comparison to the rest of the Snoqualmie basin (Table 14), AUs in the Raging River planning unit rank third for importance and third for degradation to overall water flow process, As such, the *general land use recommendation for the Raging River is lowest Conservation & Development.*

Using the scale 2 results for the sub-components of the water flow process (Figure 31) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation scores. When assessing the Raging River planning unit for predominant areas of highest importance to specific water flow processes we can target the following: *Protection & conservation of delivery and recharge processes in the upper watershed.*

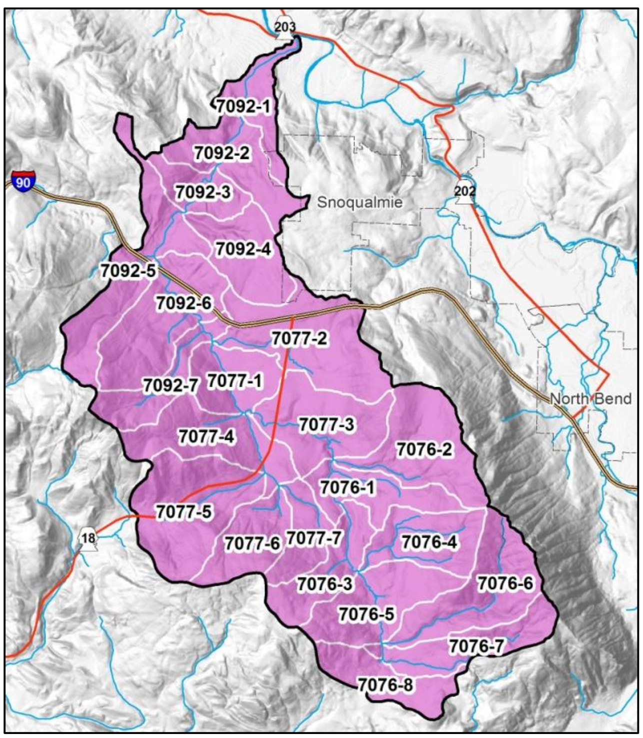



**Figure 75. The assessment units of the Raging River planning unit.** Note, the assessment units are Type II, indicating that they have been re-delineated for the water flow assessment at scale 3 to provide a greater range of comparisons.

### Scale 3 water flow results

The Raging River planning unit (scale 3) is a Type II delineation for the water flow results. New AUs were delineated given the small relative size of the planning unit. These new AUs are smaller to allow for a finer scale comparison within the planning unit to identify high priority areas for water flow processes. Given the different delineation, these scale 3 results are based upon different raw values than those for the Type I AUs. Note that the sediment process degradation and local salmonid habitats assessments for scale 3 do not use the Type II delineations. So, when identifying AUs most important to water flow in this planning unit, and linking them to those important for sediment or salmonid habitats, the relationship is not direct.

Those areas in a watershed which may account for the AU's score using the sediment or Habitat results cannot be directly attributed to the same areas in the smaller, Type II AUs used to score water flow processes. Additionally, recall that the sediment and local salmonid habitat results are those from the WRIA 7 scale assessment.

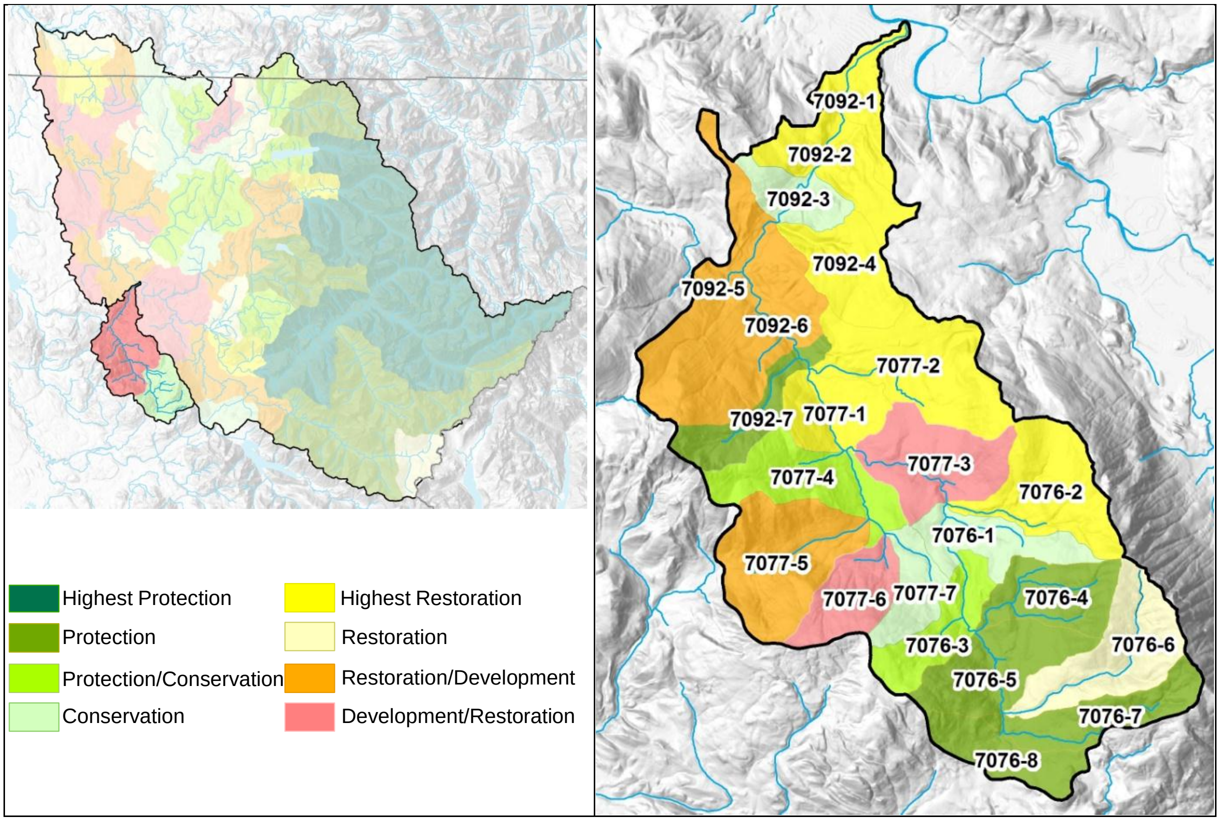



**Figure 76. Scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the Raging River planning unit.**

The scale 3 assessment results (Figure 77) can be used to determine, specific to the Raging River planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Raging River planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results (Figure 76) can help identify this, then the scale 3 results can specifically target a selection of AUs. The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As a result, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

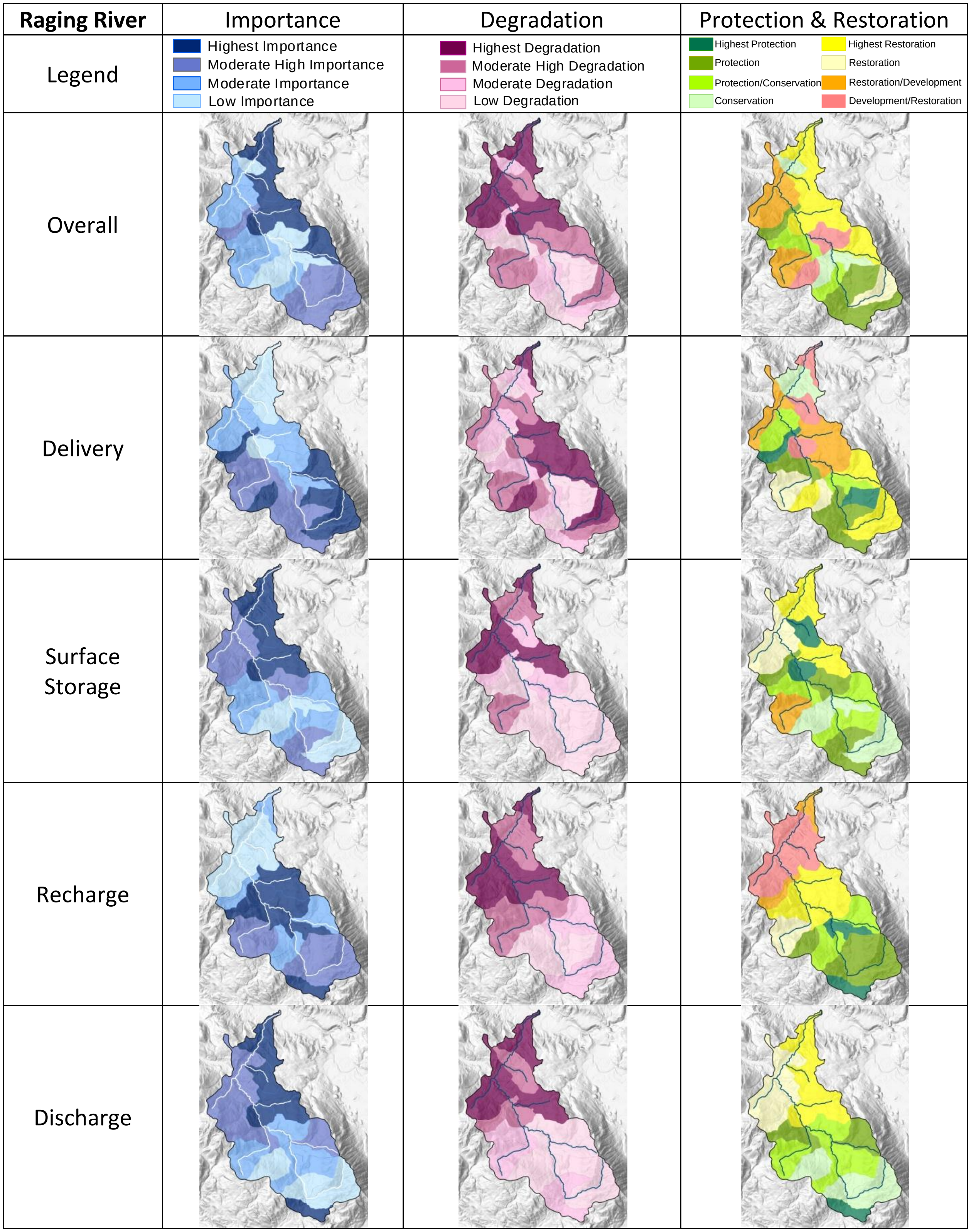



**Figure 77. Scale 3 water flow assessment results for the Raging River planning unit.**

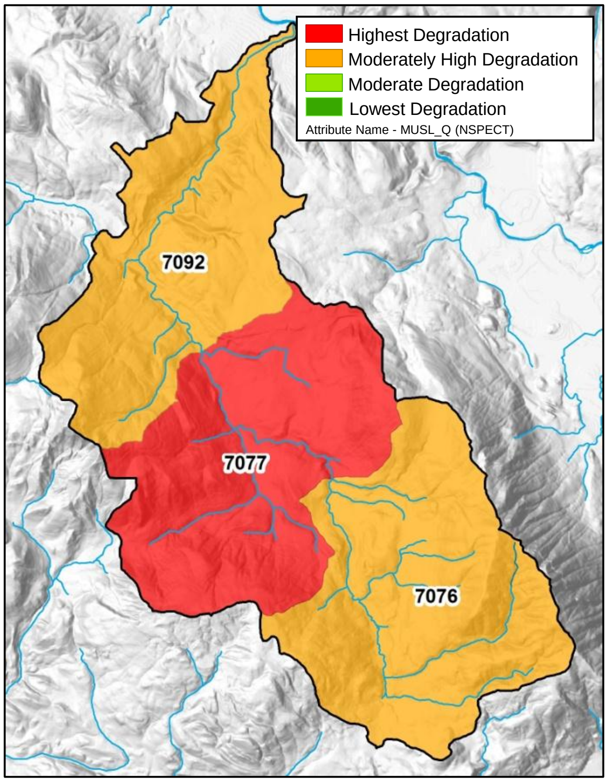



**Figure 78. Scale 1 results of  sediment process degradation for the Raging River planning unit.**

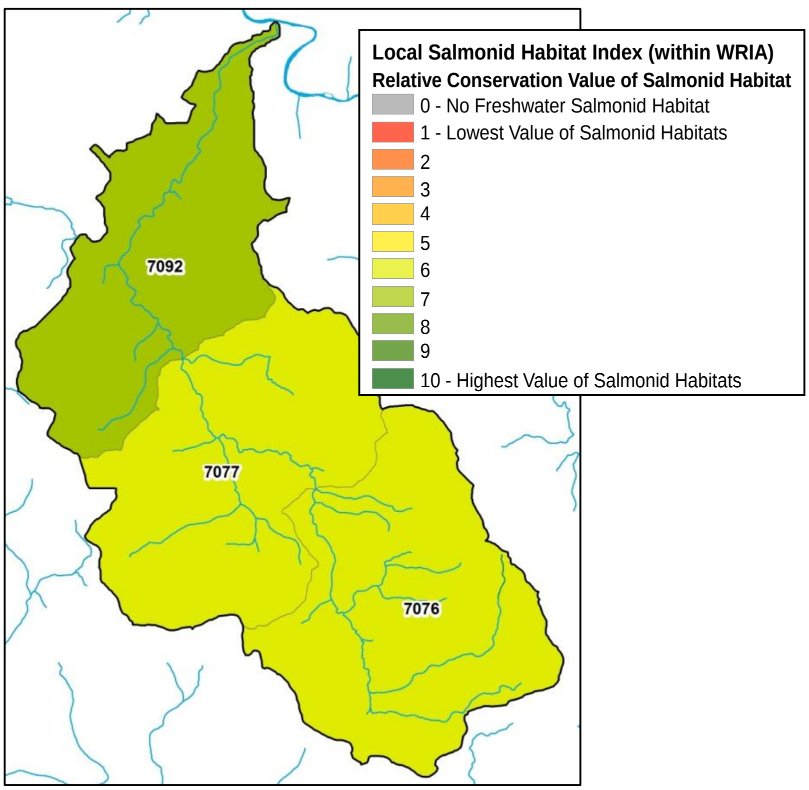



**Figure 79. Scale 1 results of the local salmonid habitat Index (WHI) for the Raging River planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%

**Integrating assessments across scales to inform priority AUs for protection**

Table 28 and Figure 80 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 78) and salmonid habitats (using scale 1 WRIA 7 results, Figure 79) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally w*hat* other benefits may be accrued, or factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 28 below brings in the scale 2 water flow recommendations for the Raging River which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 28. Integration of assessment results for the Raging River planning unit to identify priority AUs.**

| Water Flow Importance | Water Flow Degradation | Water Quality Results – Sediment | Local Salmonid Habitats | Considerations |
|---|---|---|---|---|
| **Highest ranked AUs in Planning unit (top 25%)**<br><br>**Overall water flow**: generally in lower watershed and eastern side of the drainage – AUs 7092-1, 7092-2, 7092-4, 7077-2, 7077-1, 7076-2 | **Highest ranked (most degraded) AUs in planning unit (top 25%)**<br><br>**Overall water flow**: 7092-1, 7092-2, 7092-4 ,7092-5, 7092-6, 7077-1, 7077-2, 7076-2 | **AUs meeting cutoff (top 25%) threshold**: 7077 | **AUs meeting habitat value cutoff (deciles 8-10) threshold:** none<br><br>AU 7092 had highest WHI in this subbasin. It was in the $7^{th}$ decile (i.e., among top 60 to70 % of AUs in WRIA | **Priority AUs based on integration:**<br>***Where?***<br>**Protection Group (AU id)**: **none**<br>**Restoration Group (AU id)**: 7092-1, 7092-2, 7092-4, (-)7077-2, (-)7077-1, 7076-2<br>***What?* Management considerations**<br>Protection: No Highest priority AUs for overall water flow processes with lower levels of degradation.<br>Restoration: Highest priority AUs for overall water flow processes with higher levels of degradation. (-) indicate high potential for degraded sediment processes which could undermine protection of salmonid habitats |
| **Basin Scale (2) considerations which may apply** | | | | |
| **Highest Ranked processes**: **Highest ranked subcomponents**: No highest ranked, but delivery is moderate-high in upper watershed | **Highest Ranked processes**: **Highest ranked (most degraded) subcomponents**: recharge, discharge in the lower watershed | | | **<u>Water flow</u>**<br>**overall land use recommendation:** Conservation & Development<br>**Priority water flow processes to protect and restore**: Protect delivery and recharge in upper watershed |

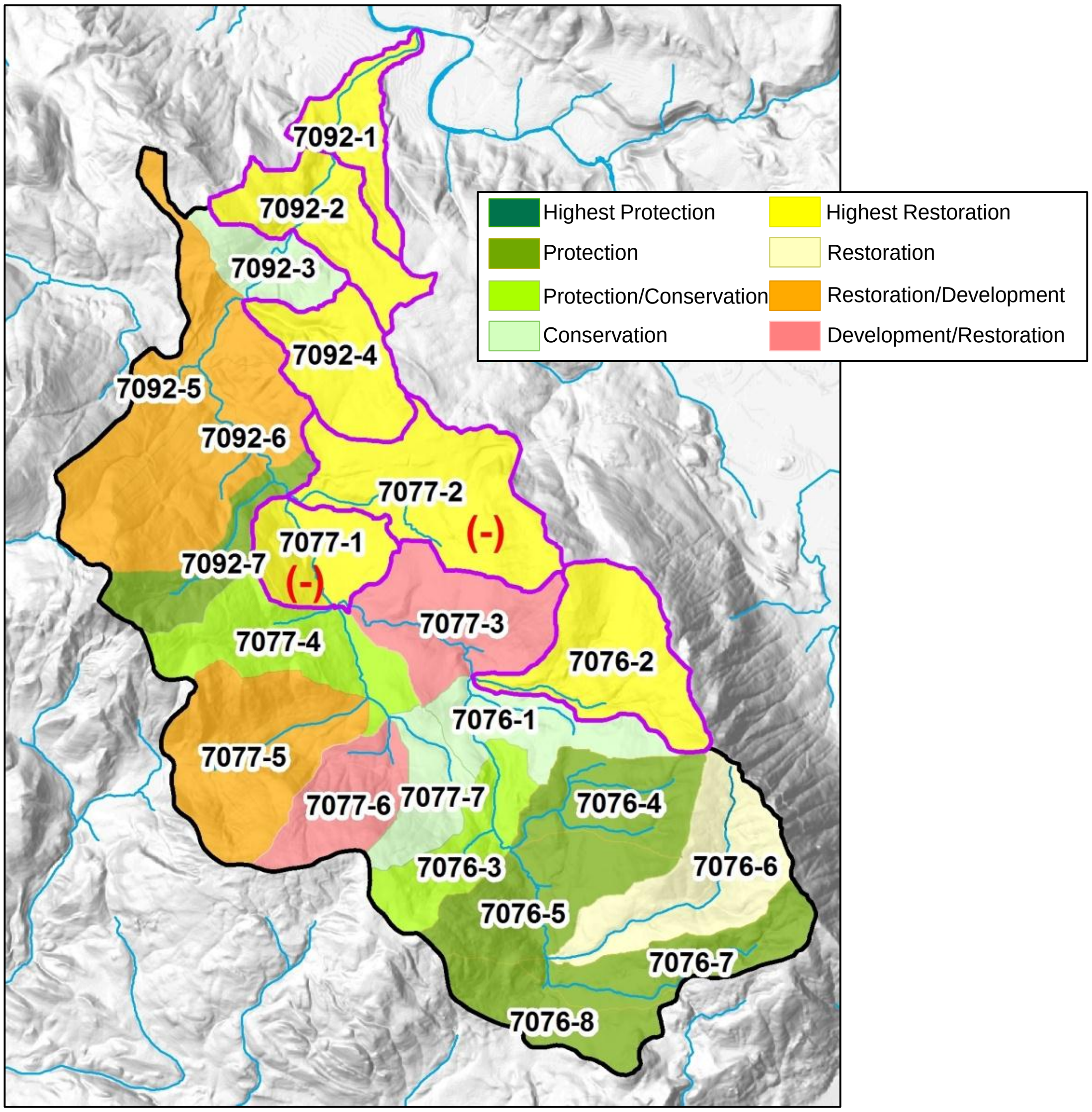



**Figure 80. Highest priority assessment units for protection of water flow processes in the Raging River planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## Upper Snoqualmie Planning unit

The Upper Snoqualmie planning unit is comprised of three main forks: the North, Middle and South Fork (Figure 81). In comparison to the rest of the Snoqualmie basin (Table 14), AUs in the Upper Snoqualmie planning unit generally rank highest for importance and lower for degradation to overall water flow process. As such, the *general land use recommendation for the Upper Snoqualmie is Protection.*

Using the scale 2 results for the sub-components of the water flow process (Figure 31) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration. Across the Upper Snoqualmie, both the delivery and recharge exhibit predominant areas of highest ranked AUs for importance and lowest ranked AUs for degradation which indicate these may be considered priority processes to target protection efforts for water flow. Given the size of the Upper Snoqualmie, it may be helpful to target processes specific to one of the three major tributaries (North, Middle and South Forks of the Snoqualmie). When assessing each tributary individually to look for predominant areas of highest importance to specific water flow processes we can target the following:

- North Fork- *Protection of delivery & recharge; restoration of delivery & recharge processes in mid reaches*
- Middle Fork- *Restoration of storage; protection of delivery and recharge processes*
- South Fork- *Protection of delivery & recharge processes*

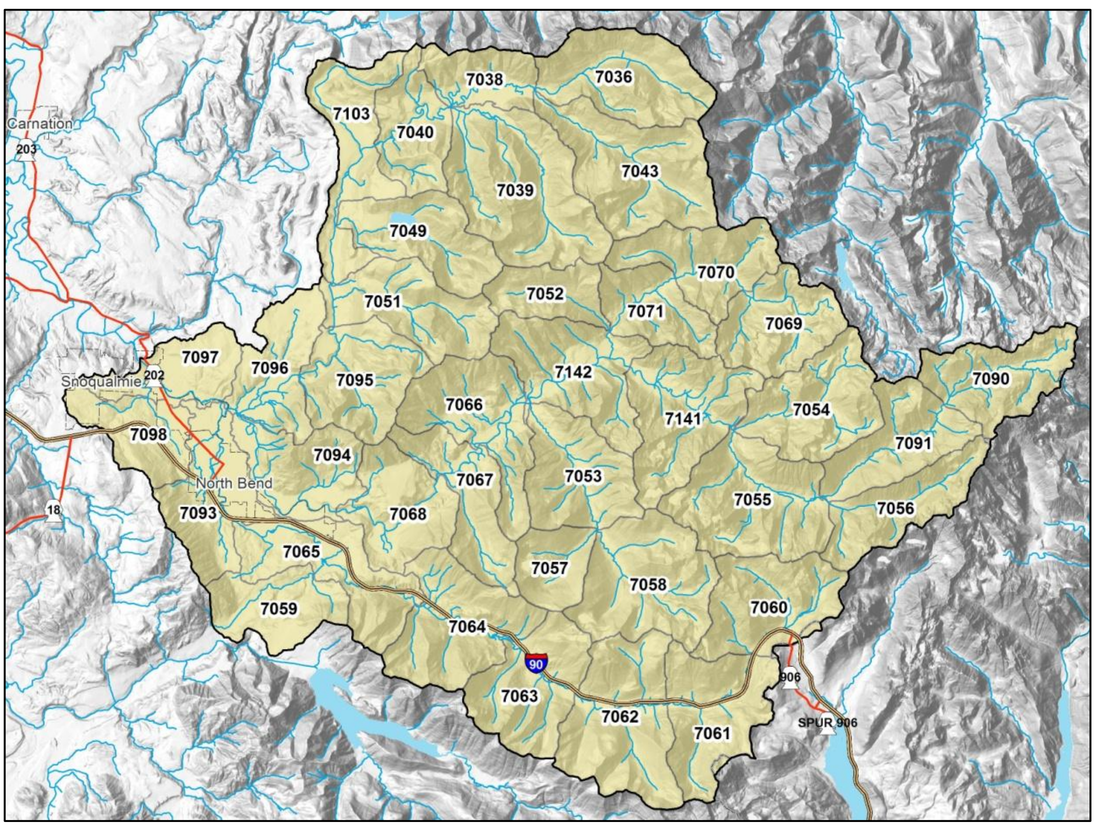



**Figure 81. The assessment units of the Upper Snoqualmie planning unit.**

**Scale 3 Water Flow results**

The scale 3 water flow assessment for the Upper Snoqualmie (Figure 83) planning unit uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

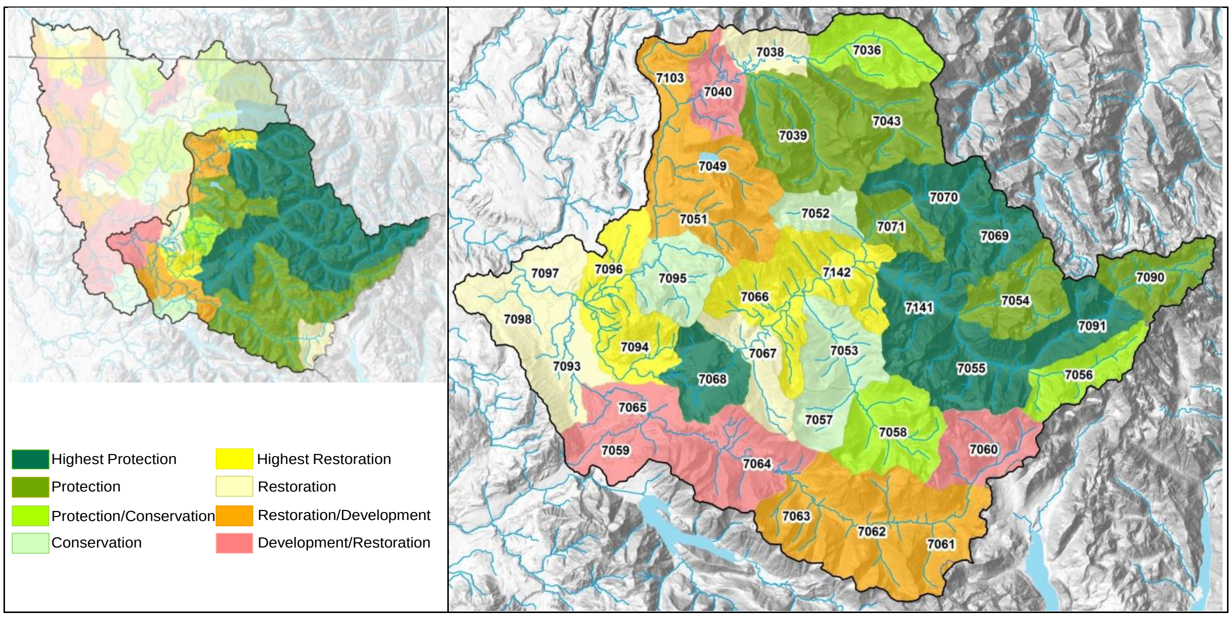



**Figure 82. Scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the Upper Snoqualmie planning unit.**

The scale 3 assessment results can be used to determine, specific to the Upper Snoqualmie planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Upper Snoqualmie planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs (Figure 82). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. As a result, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7.*

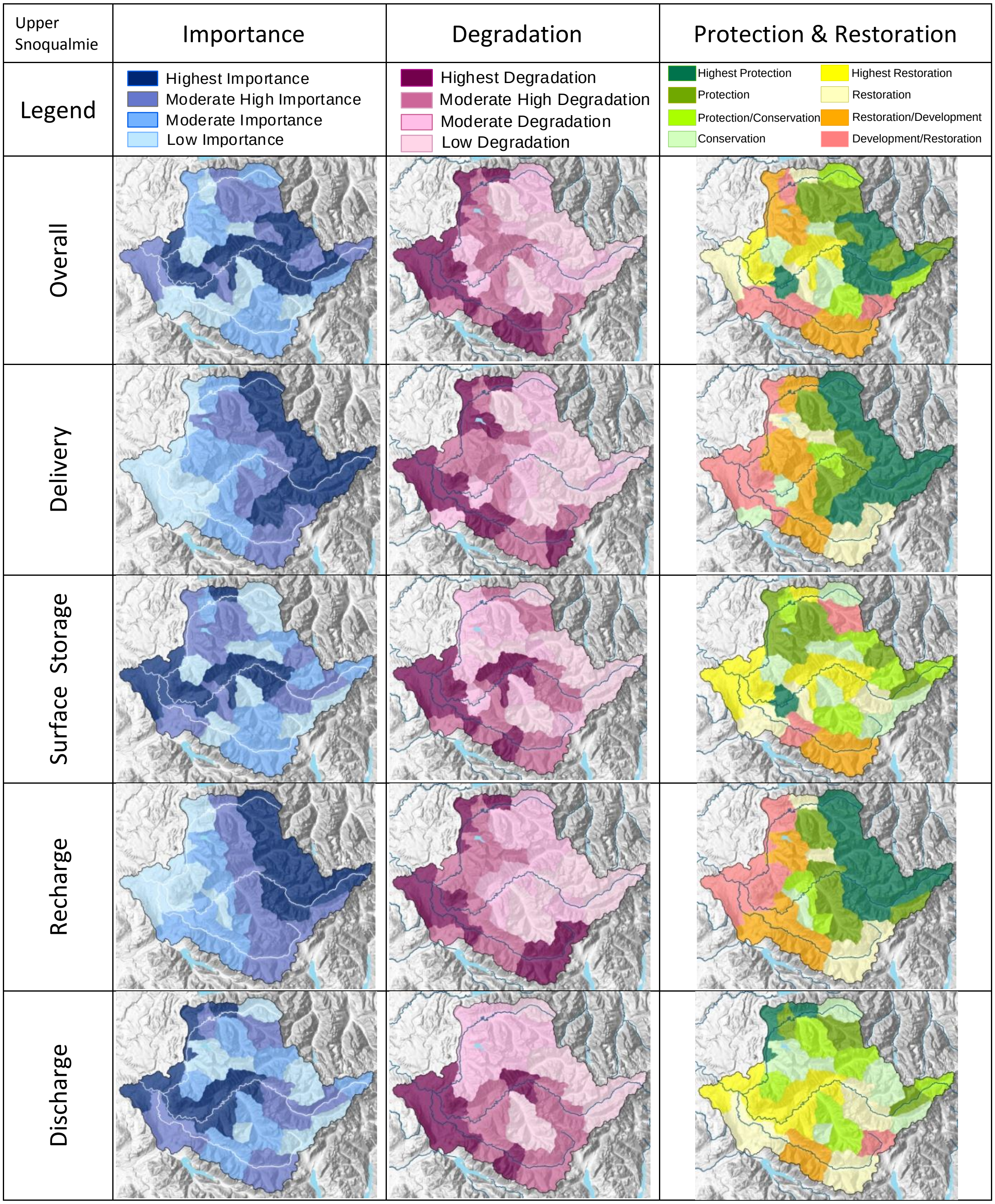



**Figure 83. Scale 3 water flow assessment results for the Upper Snoqualmie planning unit.**

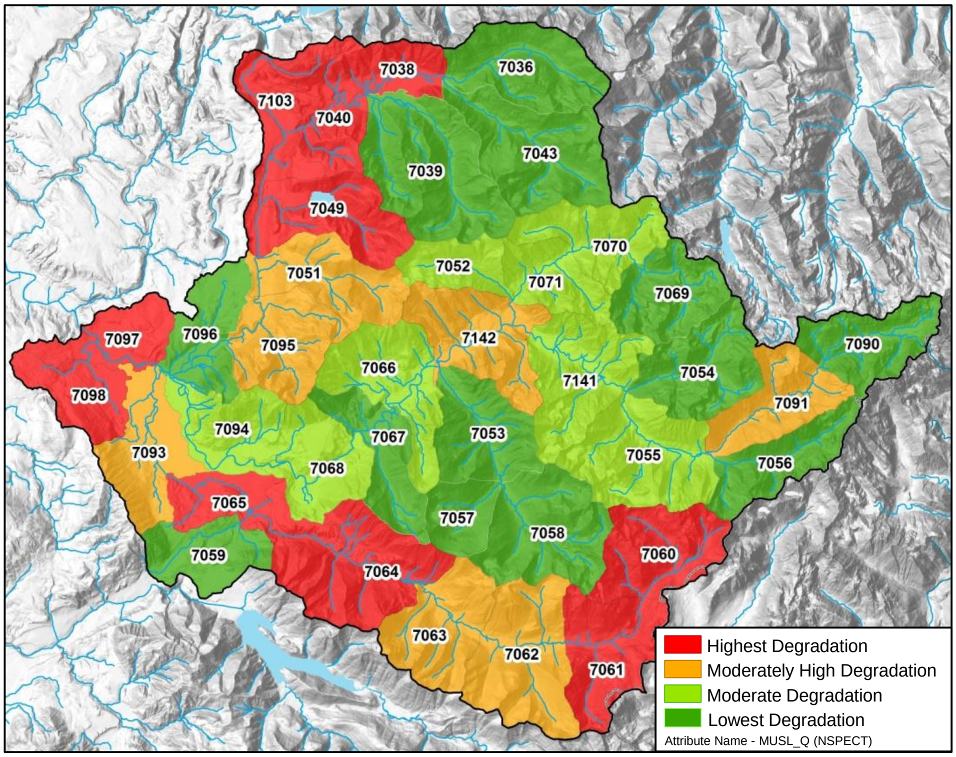



**Figure 84. Scale 1 results of sediment process degradation for the Upper Snoqualmie planning unit.**

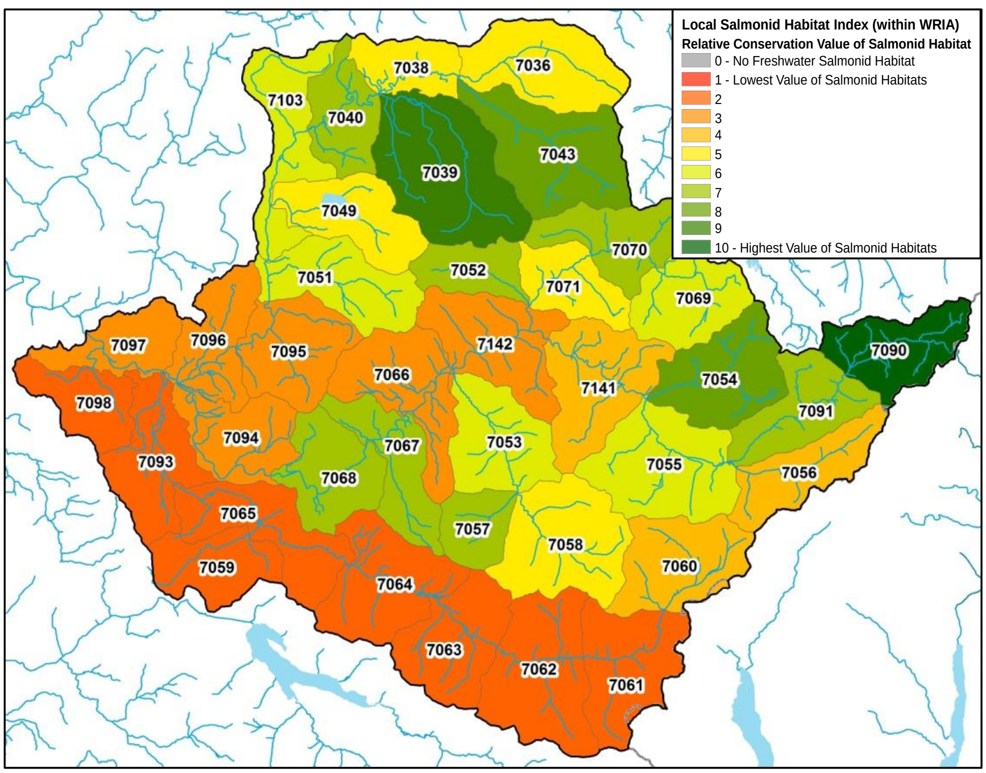



**Figure 85. Scale 1 results of the local salmonid habitat Index (WHI) for the Upper Snoqualmie River planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 29 and Figure 86 provide an integrated look at the assessments for water flow (using scale 3 results), sediment degradation (using scale 1 WRIA 7 results, Figure 84) and salmonid habitats ( using scale 1 WRIA 7 results, Figure 85) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or limiting factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 29 below brings in the scale 2 recommendations for the Upper Snoqualmie which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 29. Integration of assessment results for the Upper Snoqualmie planning unit to identify priority AUs.**

<table>
<tr><th>Water Flow Importance</th><th>Water Flow Degradation</th><th>Sediment</th><th>Local Salmonid Habitats</th><th>Considerations</th></tr>
<tr>
<td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow:<br>7055, 7066, 7068, 7069, 7070, 7091, 7094, 7096, 7141, 7142</td>
<td>Highest ranked (most degraded) AUs in planning unit (top 25%)- Overall water flow:<br>7038, 7062, 7063, 7065, 7093, 7094, 7096, 7097, 7098, 7103</td>
<td>AUs meeting cutoff (top 25%) threshold:<br>7098,7097, 7065, 7064, 7061, 7060, 7049, 7103, 7040, 7038</td>
<td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7039, 7043<br>7054, 7090</td>
<td>Priority AUs based on integration:
<table>
<tr><th colspan="2">Where?</th></tr>
<tr><th>Protection Group (AU id)</th><th>Restoration Group (AU id)</th></tr>
<tr><td>7055,7141, 7070, 7068, 7069,7091</td><td>7142,7066,7094,7096</td></tr>
<tr><th colspan="2">What?<br>Management considerations</th></tr>
<tr><td>Highest priority AUs for overall water flow processes with lower levels of degradation. None of the highest priority are highest ranked for degraded sediment processes which could impact habitat protection.<br>* Indicates high relative salmonid habitat value in AU.</td><td>Highest priority AUs for overall water flow processes with higher levels of degradation. None of the highest priority meet highest threshold for degraded sediment processes which could impact habitat protection.</td></tr>
</table>
</td>
</tr>
<tr><th colspan="5">Basin Scale (2) considerations which may apply</th></tr>
<tr>
<td>Highest Ranked processes:<br>surface storage and discharge in the Lower Middle Fork<br><br>recharge and delivery in the upper reaches of all 3 forks</td>
<td>Highest Ranked processes:<br>surface storage, discharge recharge and delivery In Lower South Fork.<br>recharge in upper South Fork and lower Middle Fork</td>
<td></td>
<td></td>
<td>Water flow management considerations for the planning unit:<br>Scale 2 land use recommendation:<br>- <u>North Fork:</u> Highest Protection & Restoration<br>- <u>Middle Fork</u>: Highest Protection<br>- <u>South Fork</u>: Protection & Restoration<br><br>Highest Priority water flow processes to protect and restore:<br>- <u>North Fork</u>: Protection of delivery & recharge; restoration of delivery & recharge processes in mid reaches<br>- <u>Middle Fork</u>: Restoration of storage; protection of delivery and recharge processes<br>- <u>South Fork</u>: Protection of delivery & recharge processes</td>
</tr>
</table>

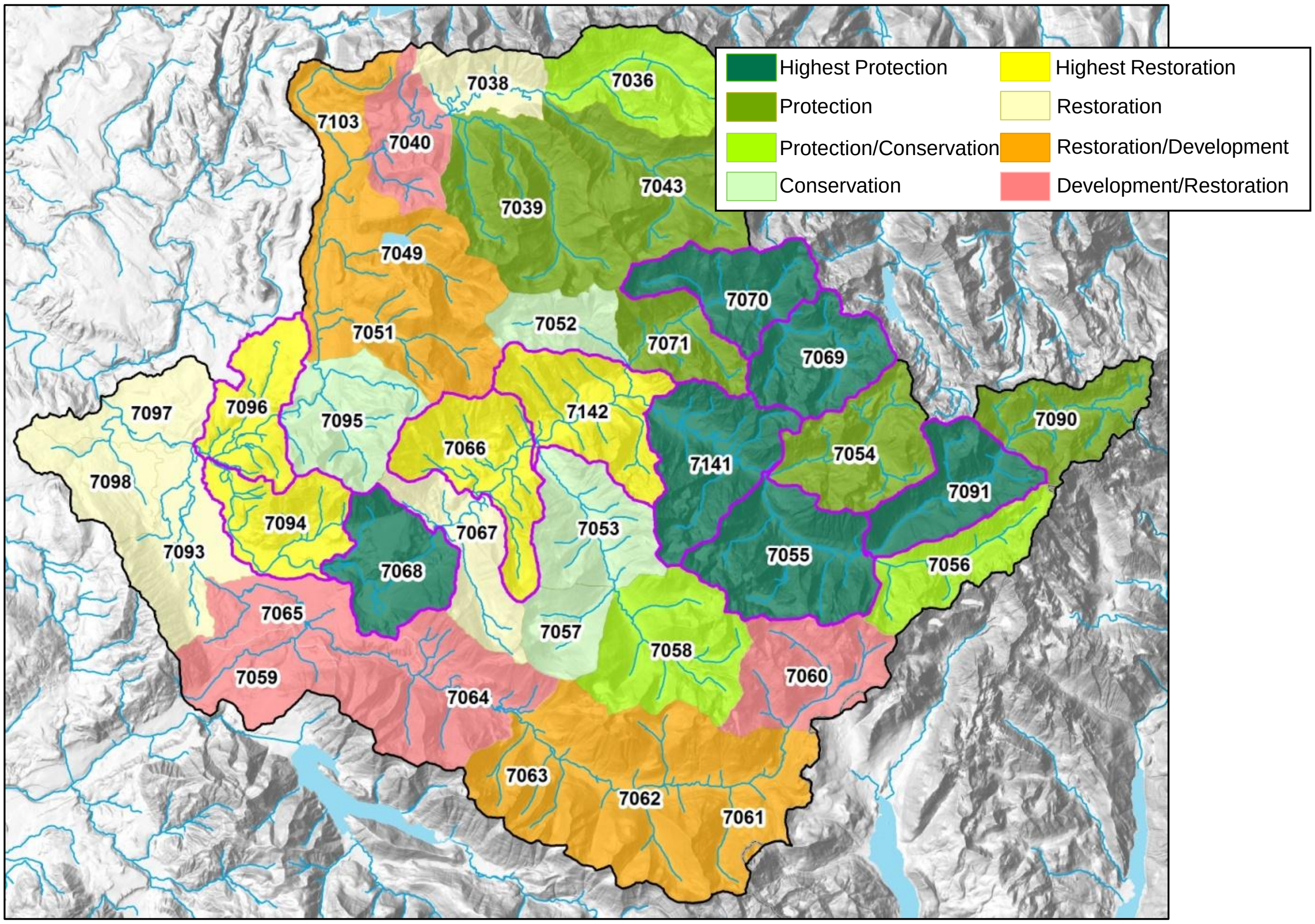



**Figure 86. Highest priority assessment units for protection of water flow processes in the Upper Snoqualmie planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes.

# Skykomish Basin Planning Units

## Woods Creek Planning Unit

The Woods Creek planning unit consists of tributaries (i.e. West Fork Woods, Sorgenfrei Creek, Roesinger Creek) running north to south into the confluence with the Skykomish River near the town of Monroe (Figure 87). The Woods Creek planning unit ranks last in the Skykomish basin for overall importance and second for overall degradation to water flow processes in the Skykomish basin (Table 18). As such the *general land use recommendation for the Woods Creek planning unit is Restoration & Development.*

Using the scale 2 results for the sub-components of the water flow process (Figure 35) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AUs relative importance and degradation. When assessing the Woods Creek planning unit for dominant areas of highest importance to specific water flow processes we can target the following: *Restore surface storage and discharge processes*

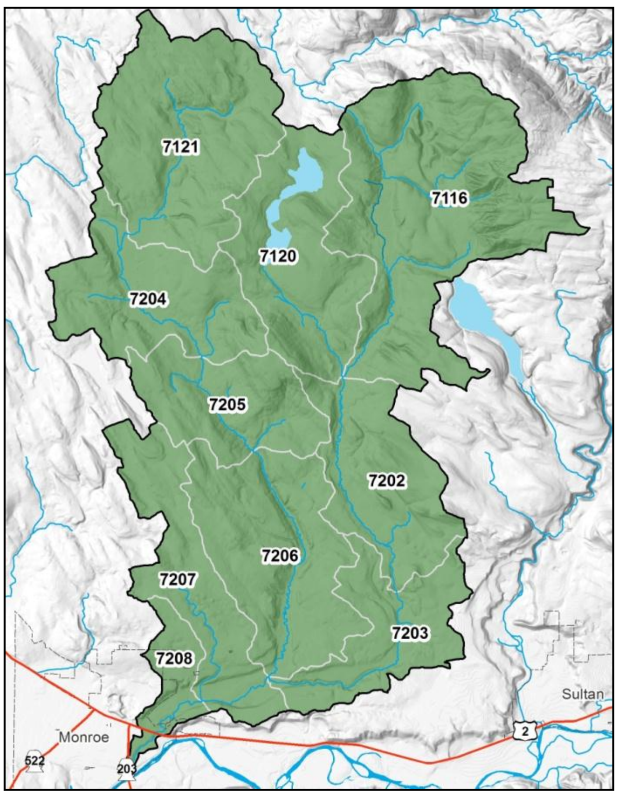



**Figure 87. The assessment units of the Woods creek planning unit.**

### Scale 3 water flow results

The scale 3 water flow assessment (Figure 89) for the Woods Creek planning unit uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). As such, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Skykomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUsto both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

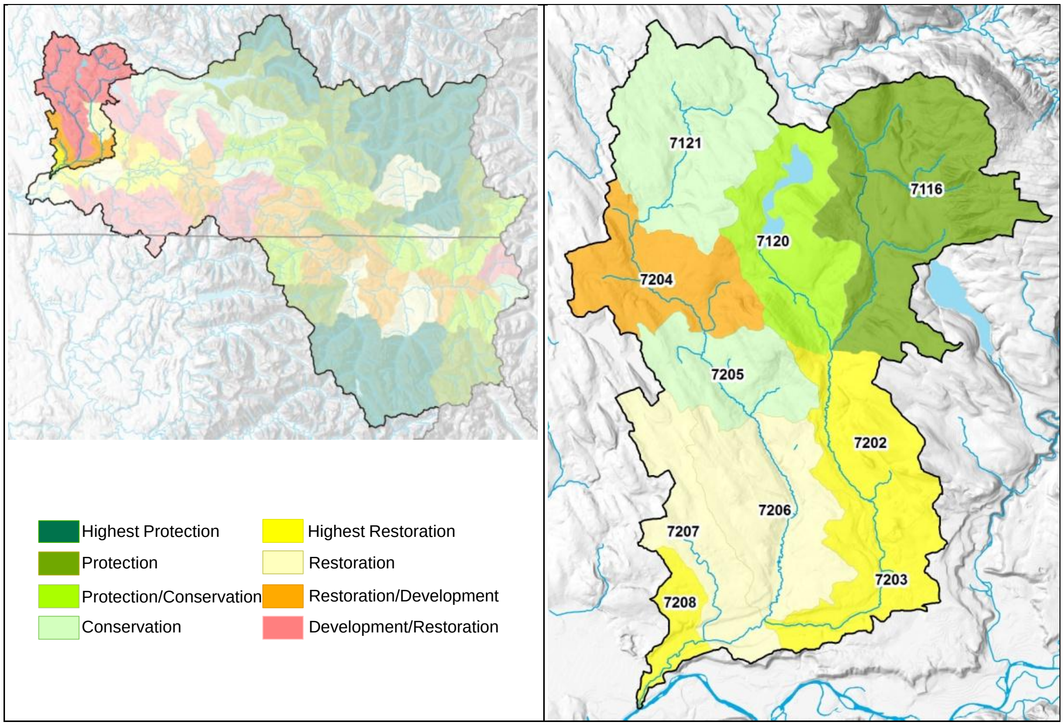



**Figure 88. Scale 2 (left panel) and scale 3 (right panel) overall water flow Protection & Restoration results for the Woods Creek planning unit in the Skykomish basin.**

The scale 3 assessment results can be used to determine, specific to the Woods Creek planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Woods Creek planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs (Figure 88). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. Thus, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7.*

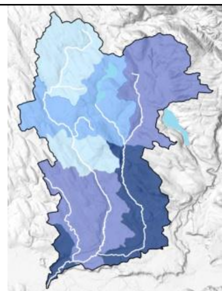
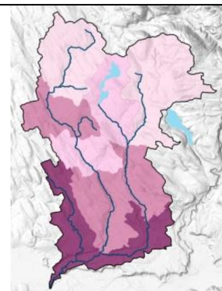
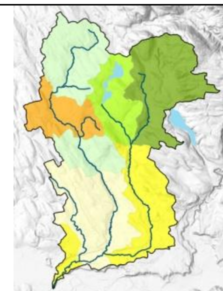
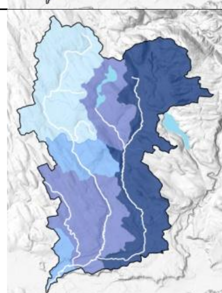
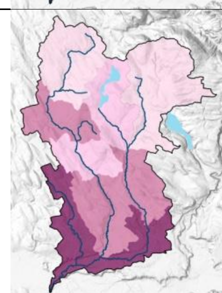
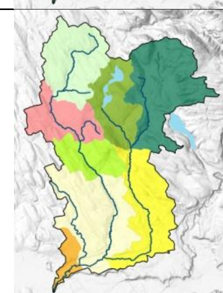
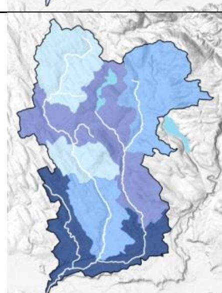
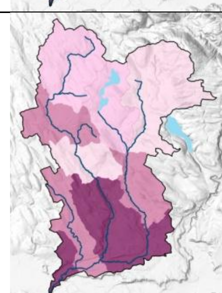
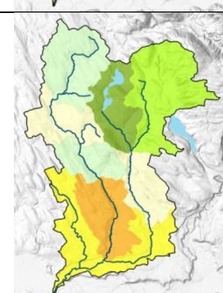
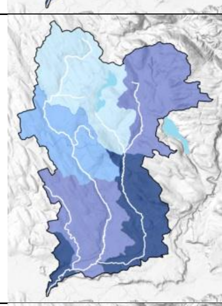
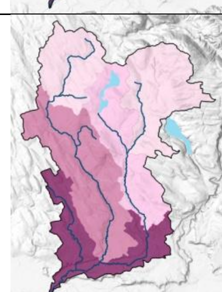
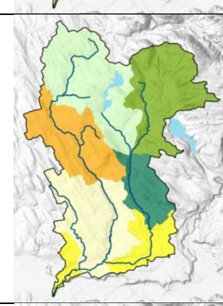
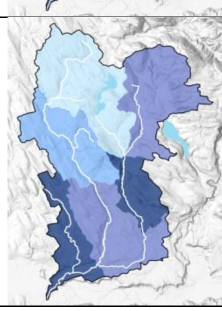
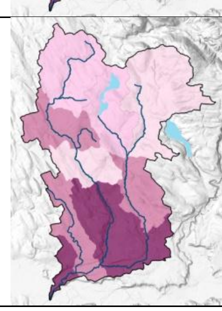
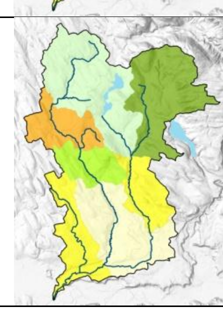
| **Woods Creek** | Importance | Degradation | Protection & Restoration |
|---|---|---|---|
| Legend | Highest Importance<br>Moderate High Importance<br>Moderate Importance<br>Low Importance | Highest Degradation<br>Moderate High Degradation<br>Moderate Degradation<br>Low Degradation | Highest Protection<br>Protection<br>Protection/Conservation<br>Conservation<br>Highest Restoration<br>Restoration<br>Restoration/Development<br>Development/Restoration |
| Overall |  |  |  |
| Delivery |  |  |  |
| Surface Storage |  |  |  |
| Recharge |  |  |  |
| Discharge |  |  |  |

**Figure 89. Scale 3 water flow assessment results for the Woods Creek planning unit.**

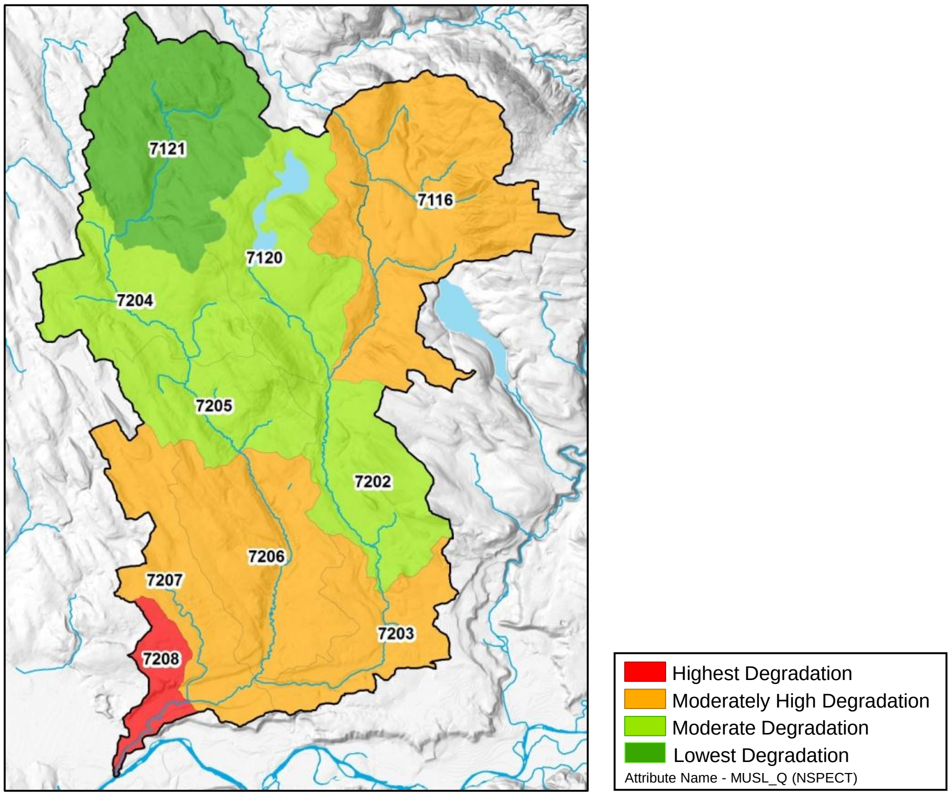



**Figure 90. Scale 1 results of sediment process degradation for the Woods Creek planning unit.**

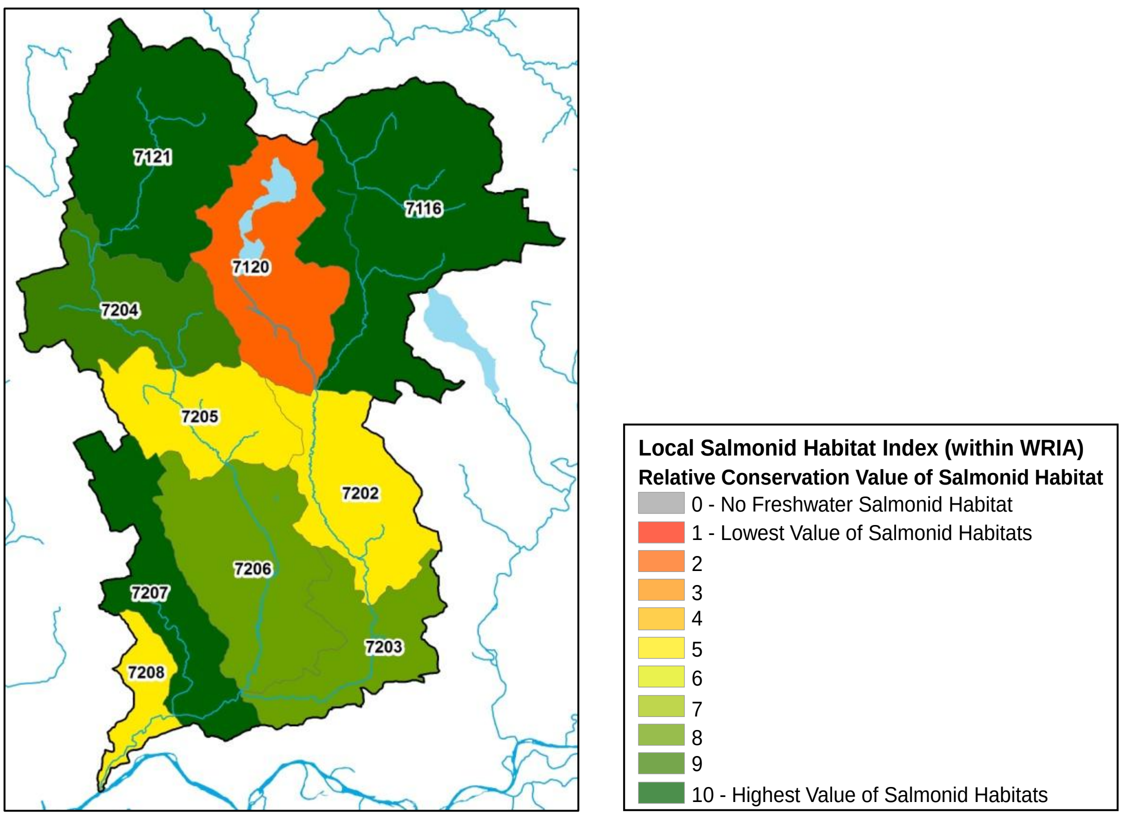



**Figure 91. Scale 1 results of the local salmonid habitat Index (WHI) for the Woods Creek planning unit.** Index values divided into deciles: 10 is top 10% of values inWRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 30 and Figure 92 provides an integrated look at the assessments for water flow (using scale 3 results), sediment process degradation (using scale 1 WRIA 7 results, Figure 90) and salmonid habitats (using scale 1 WRIA 7 results, Figure 91) to identify a selection of AUs which may represent priority areas to focus protection efforts.  This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or factors may hinder efforts based, on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 30 below brings in the scale 2 water flow recommendations for the Woods Creek planning unit. This can be used to prioritize protection or restoration of different sub-components of the water flow processes, and suggests overall land use which may be appropriate for the planning unit.

**Table 30. Integration of assessment results for the Woods Creek planning unit to identify priority AUs.**

<table>
<tr><th>Water Flow Importance</th><th>Water Flow Degradation</th><th>Water Quality Results – Sediment</th><th>Local Salmonid Habitats</th><th>Considerations</th></tr>
<tr>
<td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow: AUs in lower Roesiger Creek and at confluence with Skykomish - 7202, 7203, 7208</td>
<td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: in lower watershed AUs 7203, 7207, 7208</td>
<td>AUs meeting cutoff (top 25%) threshold: 7208</td>
<td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7116<br>7121<br>7203<br>7204<br>7206<br>7207</td>
<td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>none</td><td>7203*, (-)7208, 7202</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>No Highest priority AUs which have lower relative degradation in the planning unit.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) Indicates sediment process degradation could impact salmonid habitat protection efforts. * Indicates high relative salmonid habitat value in AU.</td></tr>
</table>
</td>
</tr>
<tr><td colspan="5">Basin Scale (2) considerations</td></tr>
<tr>
<td>Highest ranked sub-components: surface storage, discharge,</td>
<td>Highest ranked (most degraded) sub-components: surface storage, recharge, discharge, delivery:</td>
<td></td>
<td></td>
<td><u>Water flow</u>:<br>Scale 2 land use recommendation: Restoration & Development<br><br>Priority water flow processes to protect and restore: Restore surface storage and discharge</td>
</tr>
</table>

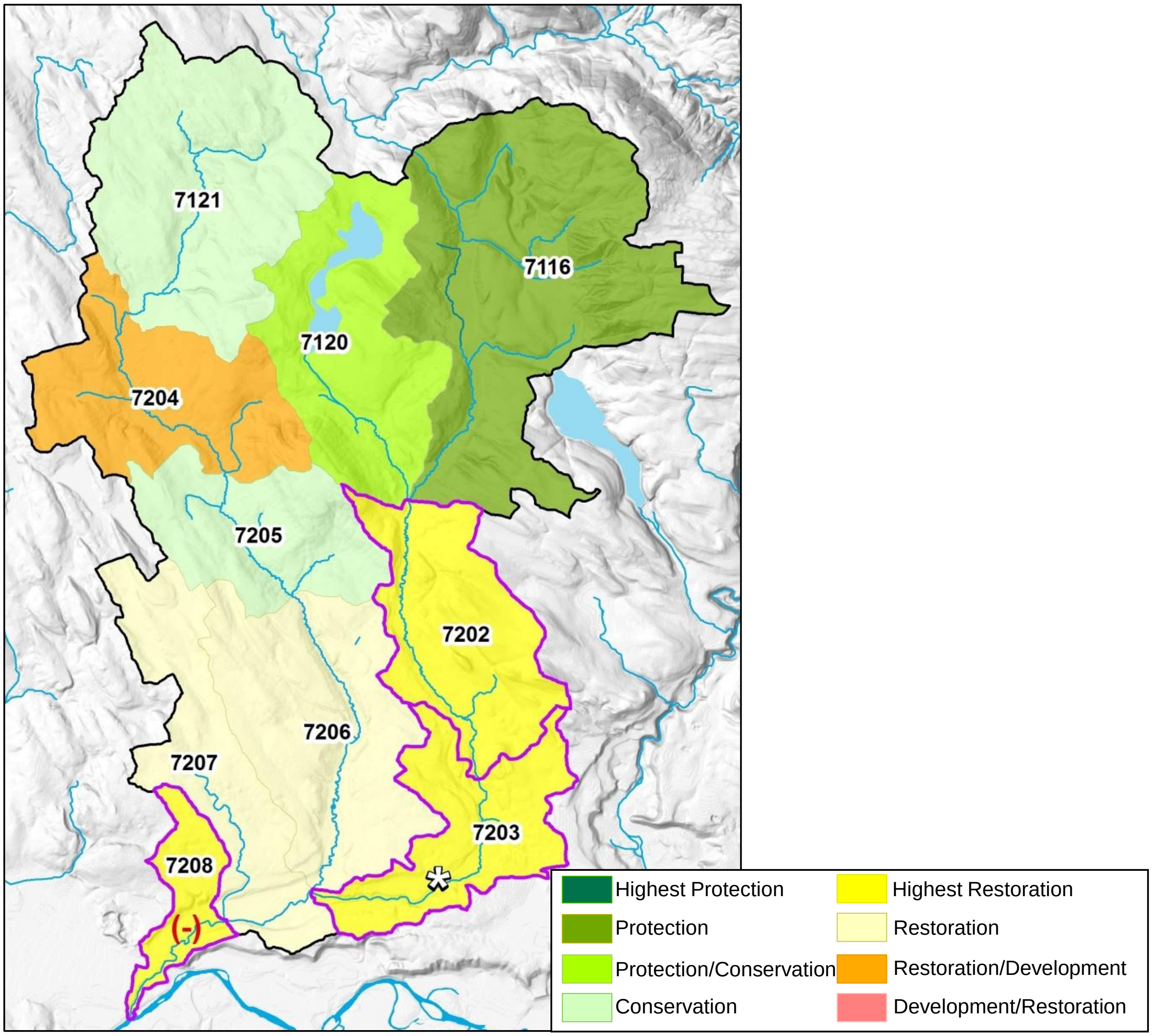



**Figure 92. Highest priority assessment units for protection of water flow processes in the Woods Creek planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## Sultan River Planning Unit

The Sultan River planning unit is comprised of the Sultan River and its tributaries, which flow into the Skykomish River mainstem near the town of Sultan (Figure 93). In comparison to the rest of the Skykomish basin the Sultan River ranks third for overall importance and third for degradation to overall water flow processes (Table 18). There is a marked difference between conditions in the upper and lower watershed. As such, the *general land use recommendation for the Sultan River planning unit is Protection in Upper Watershed, Restoration & Development in the lower watershed.*

Using the scale 2 results (Figure 35) for the sub-components of the water flow process we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation. When assessing the Sultan River planning unit for predominant areas of highest importance to specific water flow processes we can target the following:

Upper watershed: *Protection of surface storage and recharge*
Lower watershed: *Restoration of discharge and surface storage*

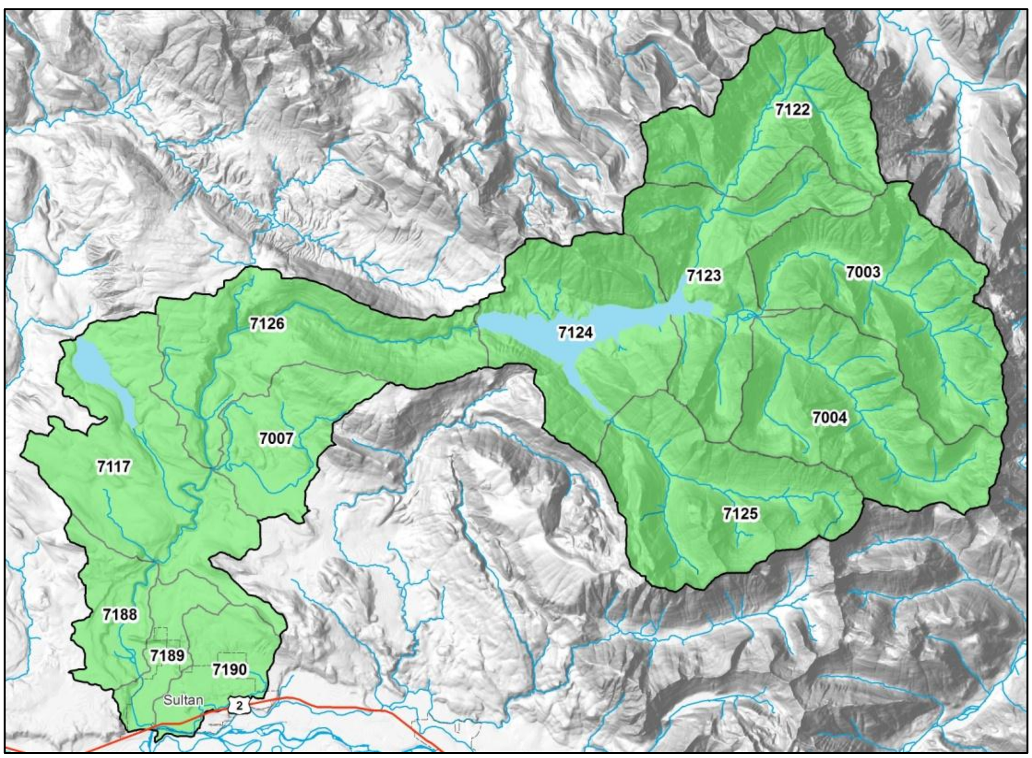



**Figure 93. The assessment units of the Sultan River planning unit.**

### Scale 3 water flow results

The scale 3 water flow assessment for the Sultan River (Figure 95) planning unituses the original AUs as the size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). So, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Skykomish) or WRIA. As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons. The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

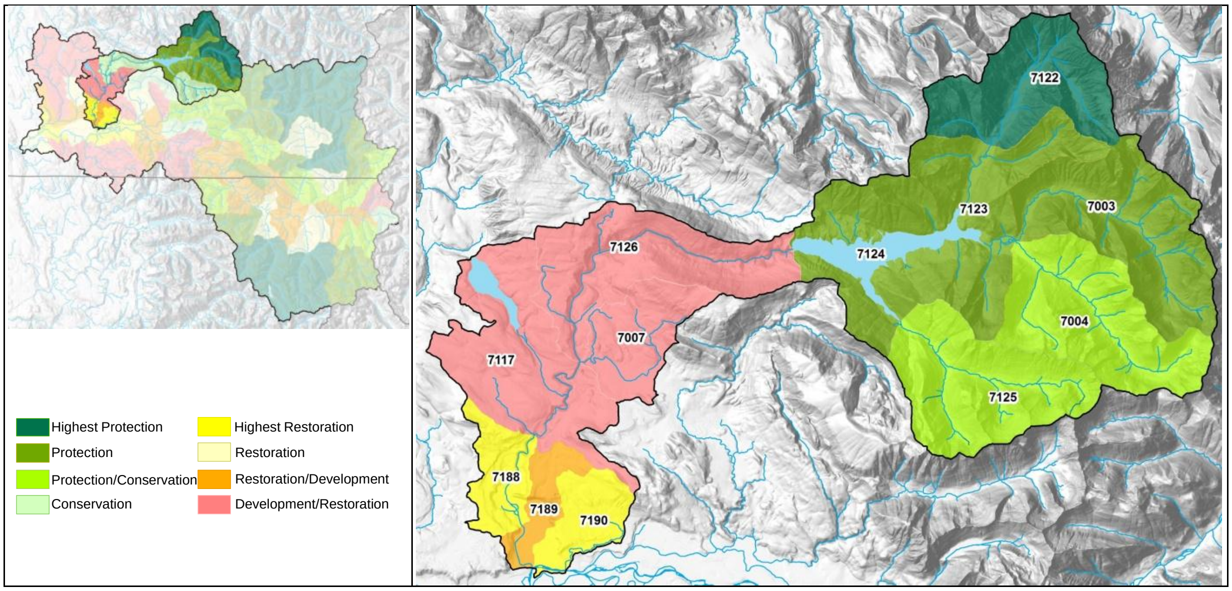



**Figure 94. Scale 2 (left panel) and scale 3 (right panel) overall water flow Protection & Restoration results for the Sultan River planning unit.**

The scale 3 assessment results can be used to determine, specific to the Sultan River planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Sultan River planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this, then the scale 3 results can specifically target a selection of AUs (Figure 94). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. Thus, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

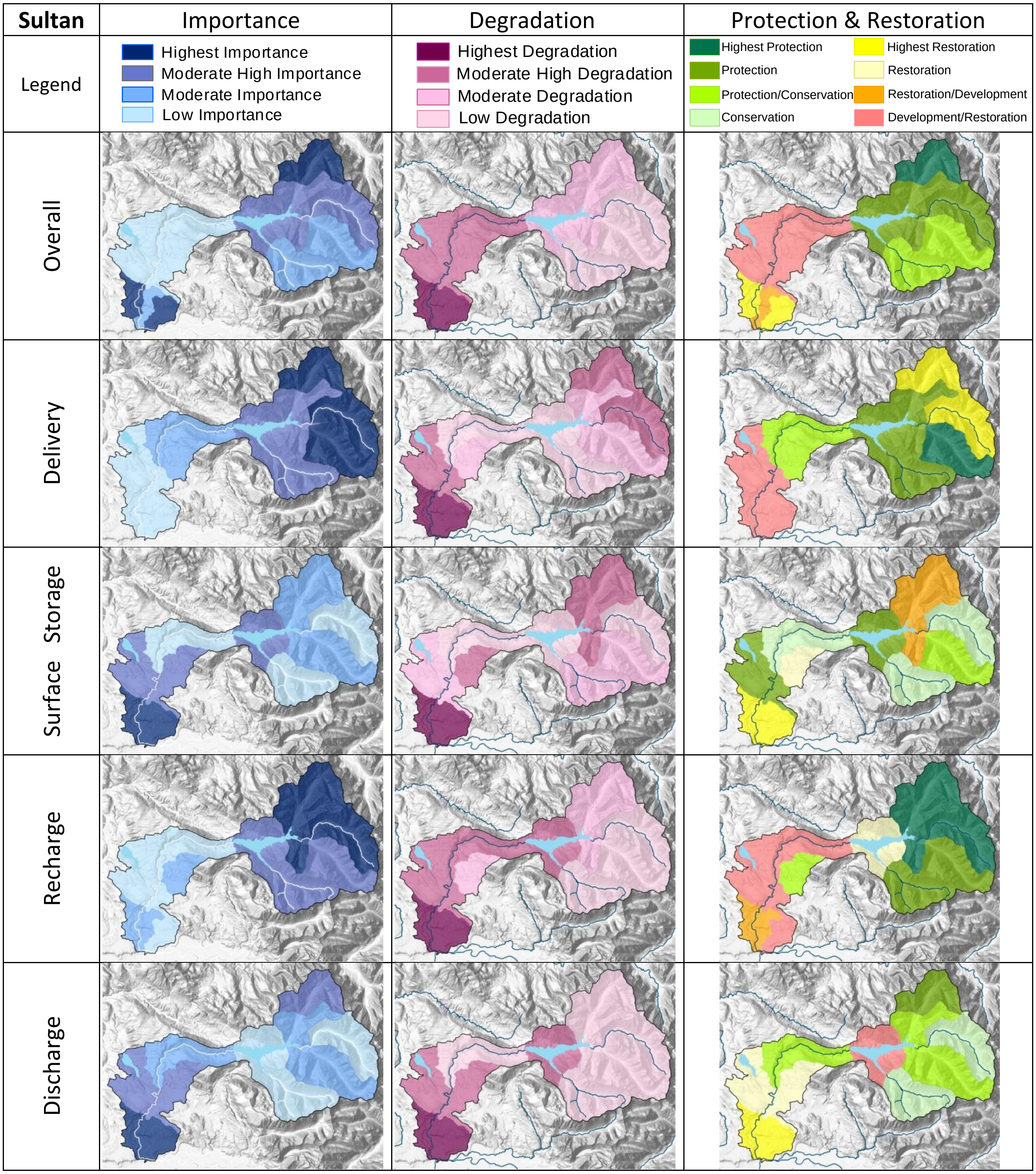



**Figure 95. Scale 3 water flow assessment results for the Sultan River planning unit.**

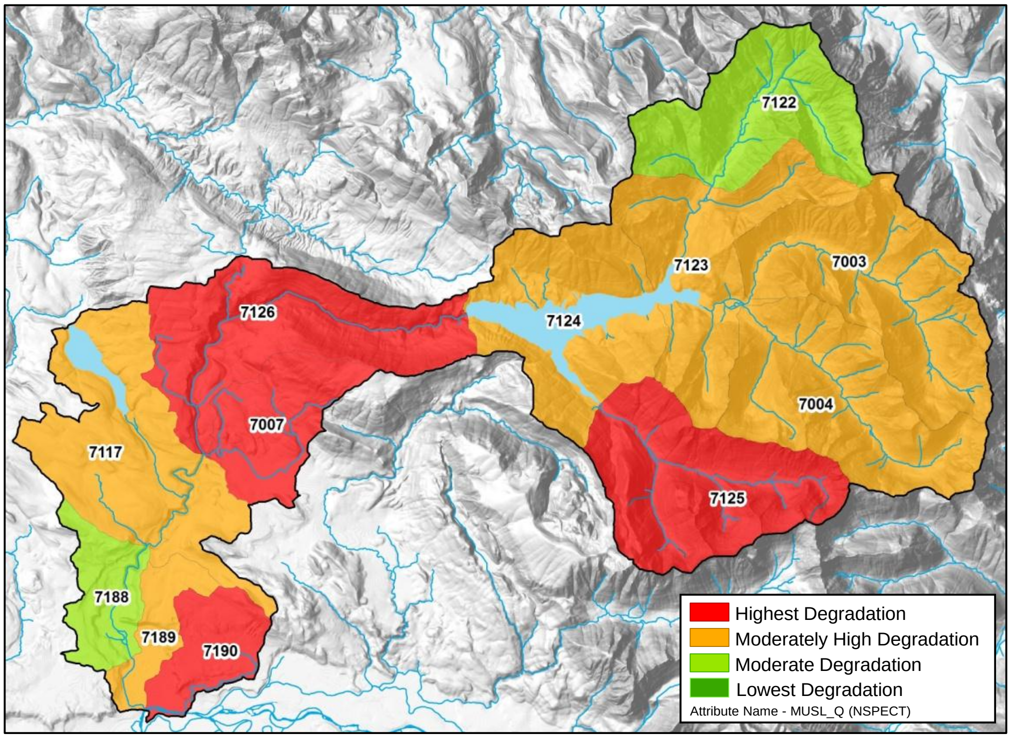
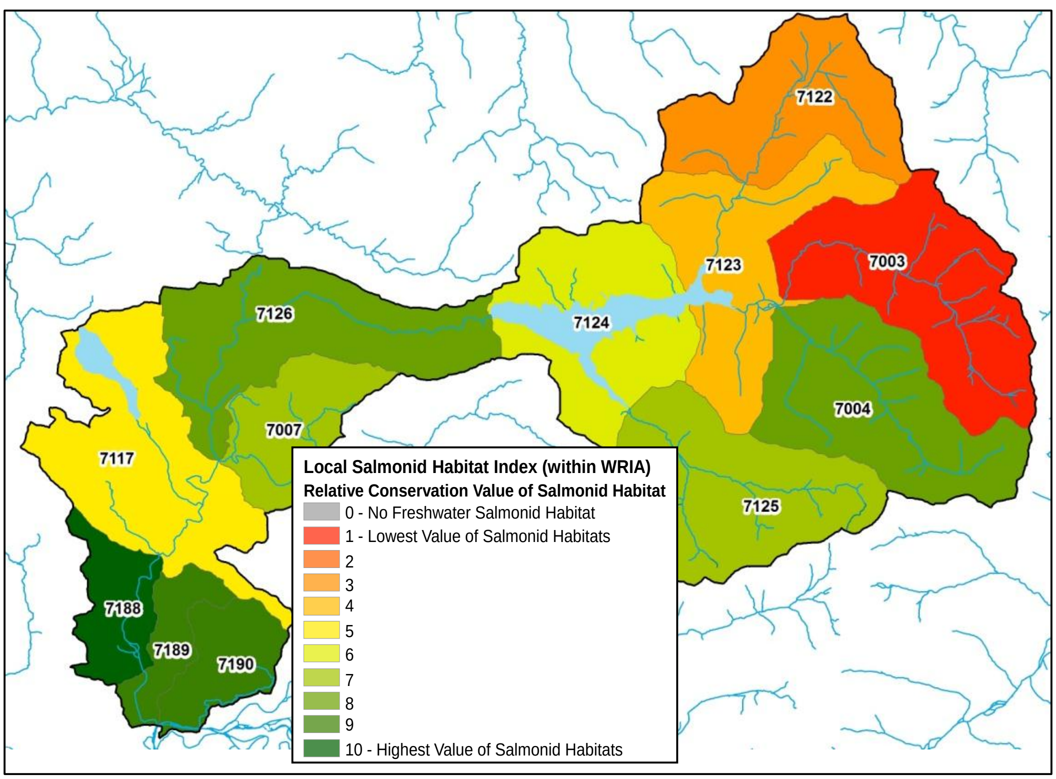



**Figure 96. Scale 1 results of sediment process degradation for the Sultan River planning unit.**




.

**Figure 97. Scale 1 results of the local salmonid habitat Index (WHI) for the Sultan River planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 31 and Figure 98 provide an integrated look at the assessments for Water flow (using scale 3 results), sediment process degradation (using scale 1 WRIA 7 results, Figure 96) and salmonid habitats (using scale 1 WRIA 7 results, Figure 97) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes, and generally *what* other benefits may be accrued, or factors may hinder efforts based on the assessments for local salmonid habitat value and sediment process degradation.

Additionally, Table 31 below brings in the scale 2 water flow recommendations for the Sultan River which can also be used to prioritize protection or restoration of different sub-components of the water flow processes, and suggests overall land use which may be appropriate for the planning unit.

**Table 31. Integration of assessment results for the Sultan River planning unit to identify priority AUs.**

| Water Flow Importance | Water Flow Degradation | Water Quality Results – Sediment | Local Salmonid Habitats | Considerations |
|---|---|---|---|---|
| **Highest ranked AUs in Planning unit (top 25%)**<br><br>**Overall water flow**: AUs near confluence with mainstem Skykomish and the upper reaches of Williamson creek – 7122, 7188, 7190 | **Highest ranked (most degraded) AUs in planning unit (top 25%)**<br><br>**Overall water flow**: all near confluence with mainstem Skykomish – 7188, 7189, 7190 | **AUs meeting cutoff (top 25%) threshold**: 7125, 7126, 7007, 7190 | **AUs meeting habitat value cutoff (deciles 8-10) threshold:**<br><br>7004<br>7126<br>7188<br>7189<br>7190 | **Priority AUs based on integration:**<br>***Where?***<br>**Protection Group (AU id)**: 7122<br>**Restoration Group (AU id)**: 7188*, (-)7190*<br>***What*?**<br>**Management considerations**<br>Protection Group: Highest priority AUs which have lower relative degradation in the planning unit.<br>Restoration Group: Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) Indicates the AU may have degraded sediment processes which could impede salmonid habitat protection. * Indicates high relative salmonid habitat value in AU. |
| **Basin Scale (2) considerations** | | | | |
| **Highest ranked subcomponents**: surface storage, recharge and delivery in upper watershed, discharge in the lower watershed | **Highest ranked subcomponent**: surface storage , recharge, discharge, delivery in lower watershed | | | <u>**Water flow**</u><br>**Scale 2 land use recommendation**: Protection in Upper Watershed, Restoration & Development in the lower watershed<br><br>**Priority water flow processes to protect and restore**:<br><u>Upper watershed</u>: Protection of surface storage and recharge<br><u>Lower watershed</u>: Restoration of discharge and surface storage |

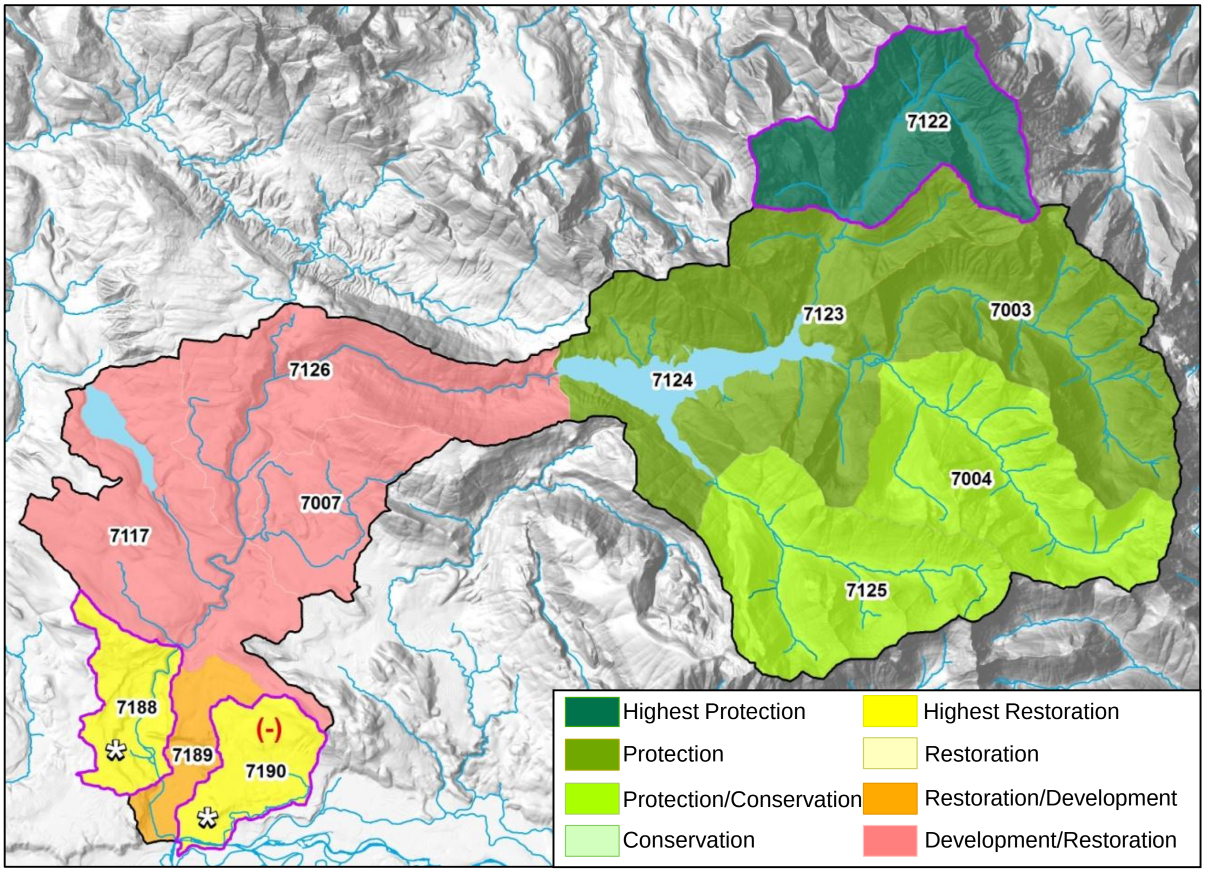



**Figure 98. Highest priority assessment units for protection of water flow processes in the Sultan River planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment degradation.

## Lower Mid-Skykomish Planning Unit

The Lower Mid-Skykomish planning unit is comprised primarily of the May, Olney and Bear Creeks, and the Wallace River drainages which flow into the Skykomish River mainstem near the town of Gold Bar (Figure 99). The planning unit ranks fourth in the basin for both overall importance and overall degradation to water flow processes (Table 18). As such the *general land use recommendation for the Lower Mid-Skykomish planning unit is Restoration & Development.*

Using the scale 2 results for the sub-components of the water flow process (Figure 35) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AU's relative importance and degradation scores. When assessing the Lower Mid-Skykomish planning unit to look for predominant areas of highest importance to specific water flow processes we can target the following: *Restoration of surface storage and discharge processes.*

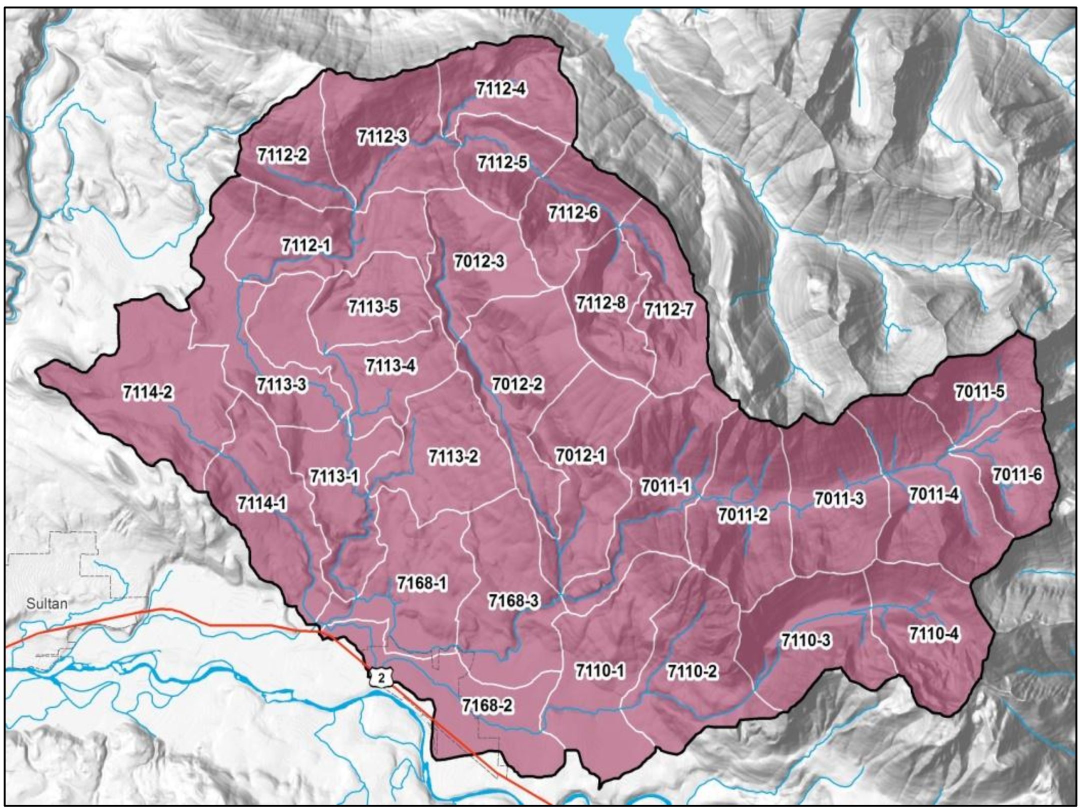



**Figure 99. The assessment units of the Lower Mid-Skykomish planning unit.** Note, the assessment units are Type II, indicating that they have been re-delineated for the water flow assessment at scale 3 to provide a greater range of comparisons.

### Scale 3 water flow results

The lower Mid-Skykomish planning unit (scale 3) is a Type II delineation for the water flow results. New AUs were delineated given the small relative size of the planning unit. These new AUs are smaller to allow for a finer scale comparison within the planning unit to identify high priority areas for water flow processes. Given the different delineation, these scale 3 results are based upon different raw values than those for the Type I AUs. Note that the sediment process degradation and local salmonid habitats assessments for scale 3 do not use the Type II delineations. So, when identifying AUs most important to water flow in this planning unit, and linking them to those important for sediment or salmonid habitats, the relationship is not direct. Those areas in a watershed which may account for the AU's score using the sediment or Habitat results cannot be directly attributed to the same areas in the smaller, Type II AUs used to score water flow processes. Additionally, recall that the sediment and local salmonid habitat results are those from the WRIA 7 scale assessment.

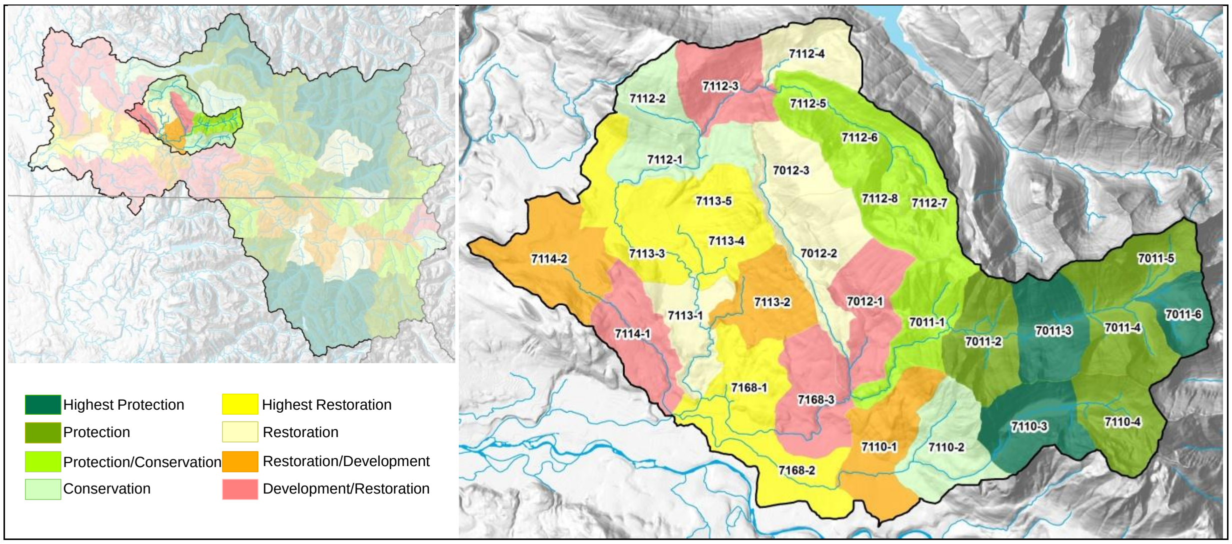



**Figure 100. The scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration for the Lower Mid-Skykomish planning unit.**

The scale 3 assessment results (Figure 101) can be used to determine, specific to the Lower Mid-Skykomish planning unit, *where* to focus protection actions for water flow processes. If an entity is prioritizing protection actions in the Lower Mid-Skykomish planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking. If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this. Then the scale 3 results can specifically target a selection of AUs (Figure 100). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation. Thus, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

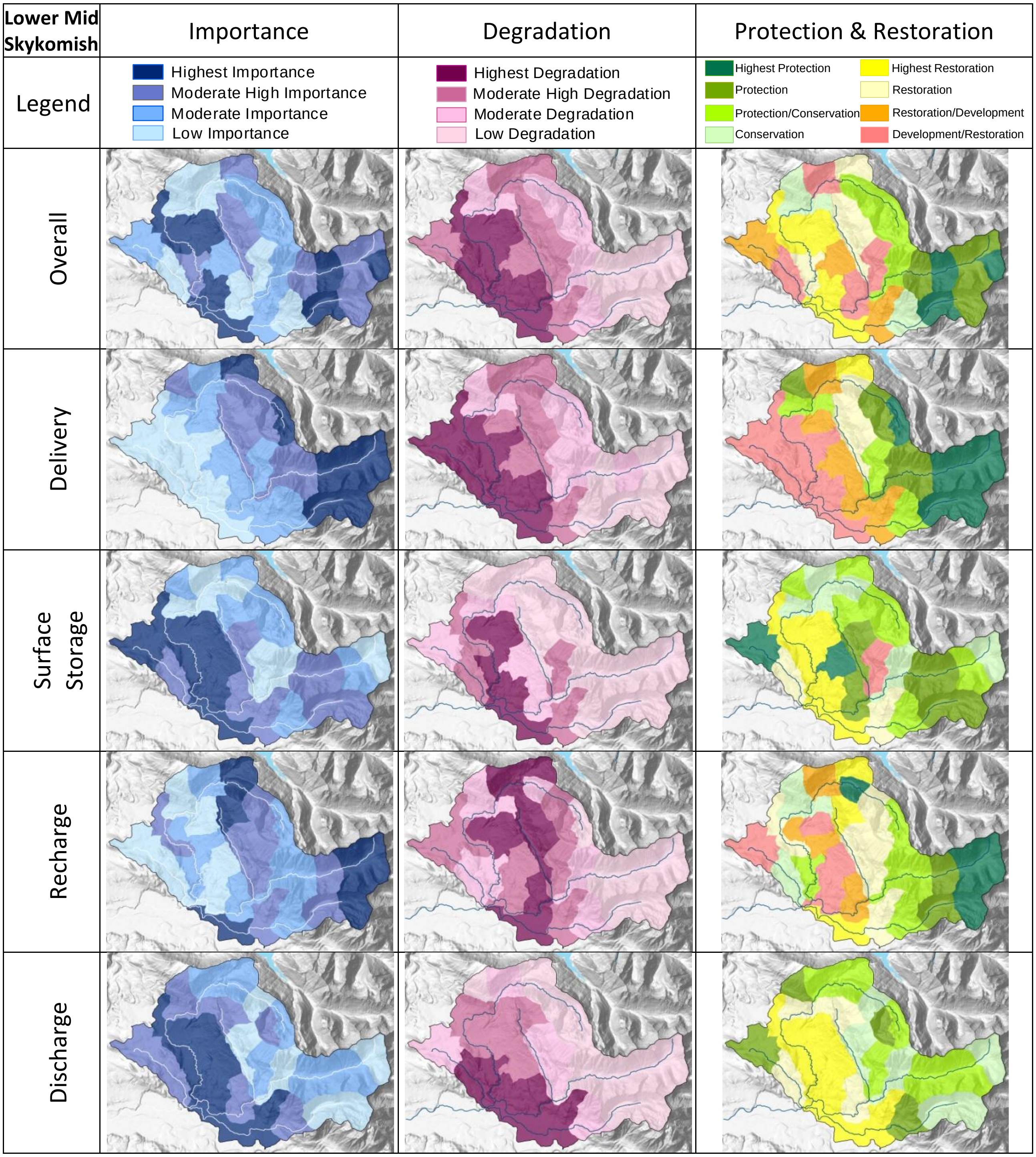



**Figure 101. Scale 3 water flow assessment results for the Lower Mid-Skykomish planning unit.**

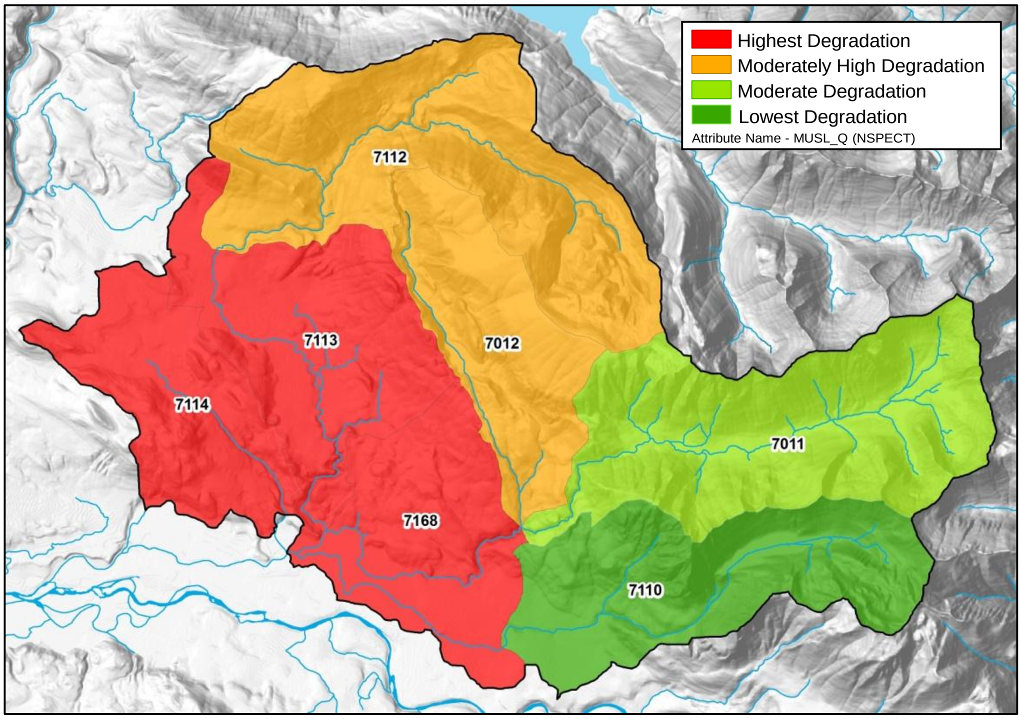



**Figure 102. Scale 1 results of sediment process degradation for the Lower Mid-Skykomish planning unit.**

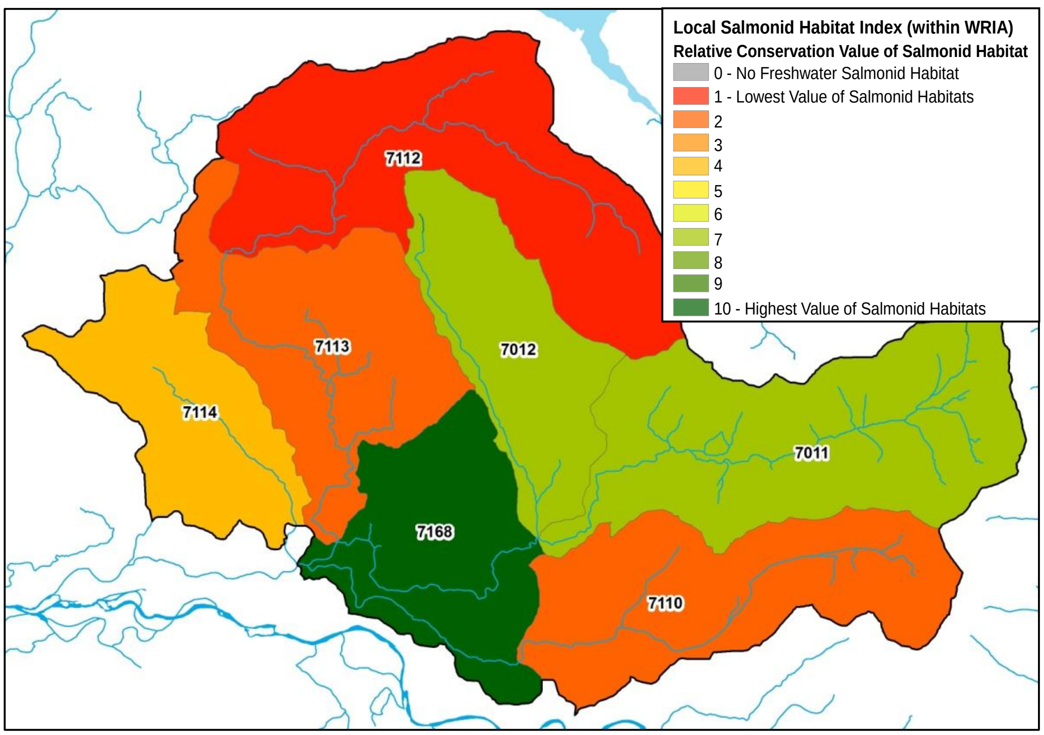



**Figure 103. Scale 1 results of the local salmonid habitat index (WHI) for the Lower Mid-Skykomish planning unit.** Index values divided into deciles: 10 is top 10% of values inWRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 32 and Figure 104 provide an integrated look at the assessments for water flow (using scale 3 results), sediment process degradation (using WRIA 7 results, Figure 102) and salmonid habitats (WRIA 7 results, Figure 103) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or what factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 32 below brings in the scale 2 water flow recommendations for the lower Mid-Skykomish planning unit which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 32. Integration of assessment results for the Lower Mid-Skykomish planning unit to identify priority AUs.**

| Water Flow Importance | Water Flow Degradation | Sediment Degradation | Local Salmonid Habitats | Considerations |
|---|---|---|---|---|
| **Highest ranked AUs in Planning unit (top 25%)**<br><br>**Overall water flow**: Generally in upper Wallace River, throughout May Creek and in lower reaches of Olney creek – AUs 7011-6, 7011-3, 7110-3, 7168-2, 7168-3, 7113-3, 7113-5, 7113-4 | **Highest ranked (most degraded) AUs in planning unit (top 25%)**<br><br>**Overall water flow**:Generally located in lower Olney, Wallace and May creeks. AUs 7113-3, 7113-5, 7113-4, 7113-1, 7114-1, 7168-1, 7168-2, 7168-3 | **AUs meeting cutoff (top 25%) threshold**: 7114, 7113, 7168 | **AUs meeting habitat value cutoff (deciles 8-10) threshold:**<br><br>7168 | **Priority AUs based on integration:**<br>***Where?***<br>**Protection Group (AU id)**: 7011-6, 7011-3, 7110-3<br>**Restoration Group (AU id)**: (-)7113-3, (-)7113-5, (-)7113-4, (-)7168-1*, (-)7168-2*,<br>***What?***<br>**Management considerations**<br>Protection: Highest priority AUs for overall water flow processes with lower levels of degradation.<br>Restoration: Highest priority AUs for overall water flow processes with higher levels of degradation. AUs with (-) indicate high potential for degraded sediment processes which could undermine protection of salmonid habitats. * Indicates high relative salmonid habitat value in AU |
| **Basin Scale (2) considerations which may apply** | | | | |
| **Highest ranked subcomponents**: surface storage, discharge, | **Highest ranked (most degraded) subcomponents**: surface storage, recharge, discharge, delivery | | | **<u>Water flow</u>**<br>**Scale 2 land use recommendation**: Restoration & Development<br><br>**Priority water flow processes to protect and restore**: Restoration of surface storage and discharge |

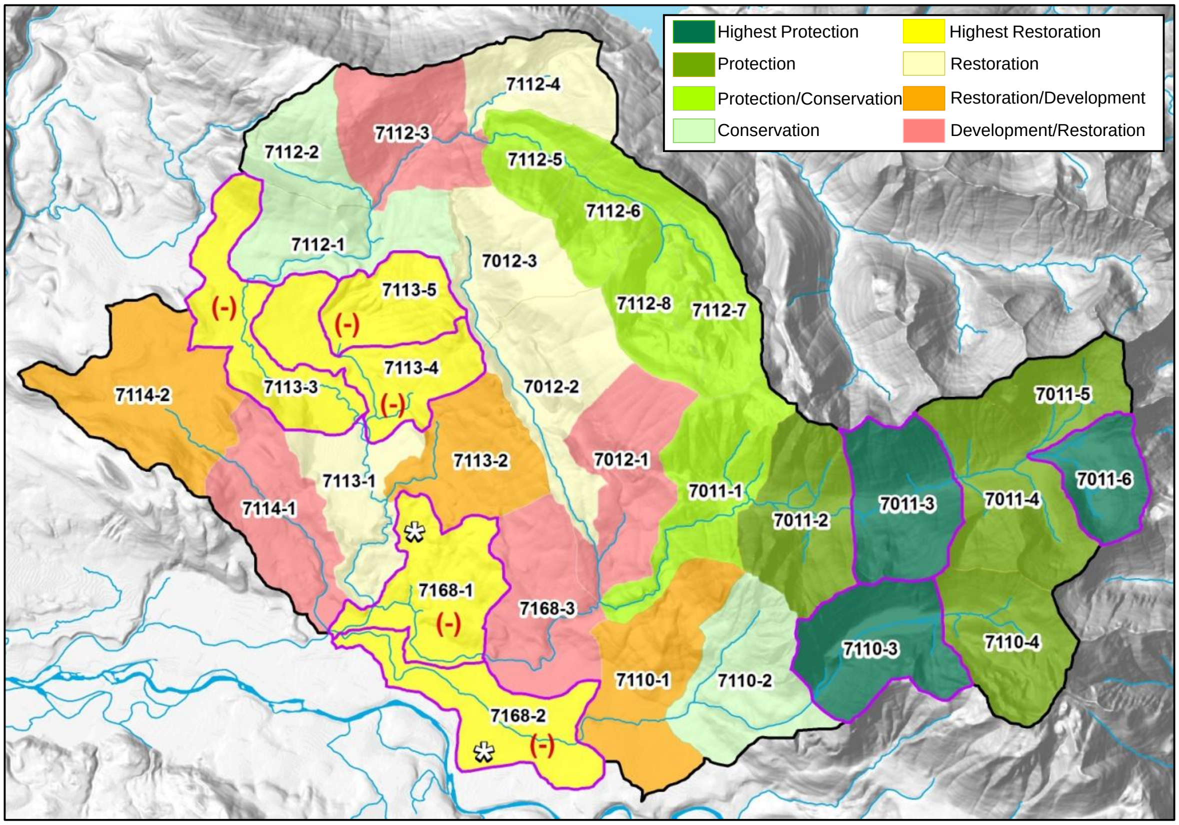



**Figure 104. Highest priority assessment units for protection of water flow processes in the Lower Mid-Skykomish planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## North Fork Skykomish River Planning Unit

The North Fork Skykomish River planning unit is comprised of the mainstem North Fork, and its tributaries (e.g. Troublesome Creek, Silver Creek, West Cady Creek, Trout creek) from the cascade crest to the confluence with the South Fork Skykomish (Figure 105). In comparison to the rest of the Skykomish basin, the AUs in the North Fork Skykomish planning unit rank highest for overall importance and lowest for overall degradation to water flow processes (Table 18). As such, the *general land use recommendation for the North Fork Skykomish is Highest Protection.*

Using the scale 2 results (Figure 35) for the sub-components of the water flow process we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AUs relative importance and degradation. When assessing the Upper North Fork planning unitfor dominant areas of highest importance to specific water flow processes, we can target the following: *Protection of delivery, protection and restoration of recharge.*

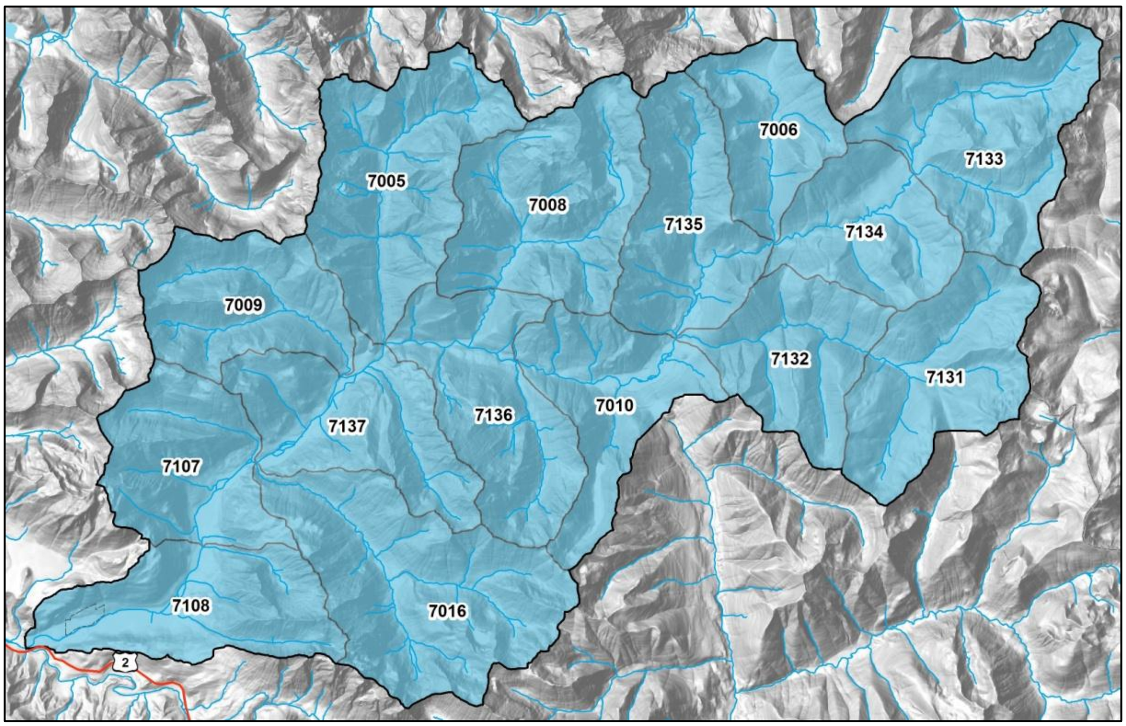



**Figure 105. The assessment units of the North Fork Skykomish planning unit.**

### Scale 3 water flow results

The scale 3 water flow assessment for the North Fork Skykomish planning unit (Figure 107) uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps). Therefore, the scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Skykomish) or WRIA. Thus, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons.  The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

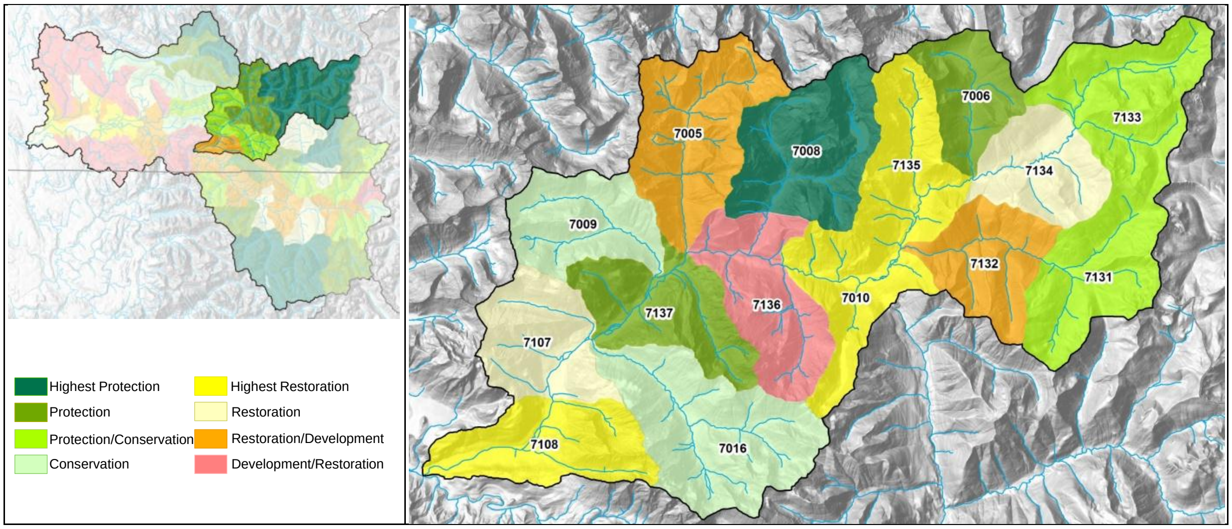



**Figure 106. Scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the North Fork Skykomish planning unit.**

The scale 3 assessment results can be used to determine, specific to the North Fork Skykomish planning unit, *where* to focus protection actions for water flow processes.  If an entity is prioritizing protection actions in the North Fork Skykomish planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking.  If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this, and then the scale 3 results can specifically target a selection of AUs (Figure 106). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation.  This means the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7.*

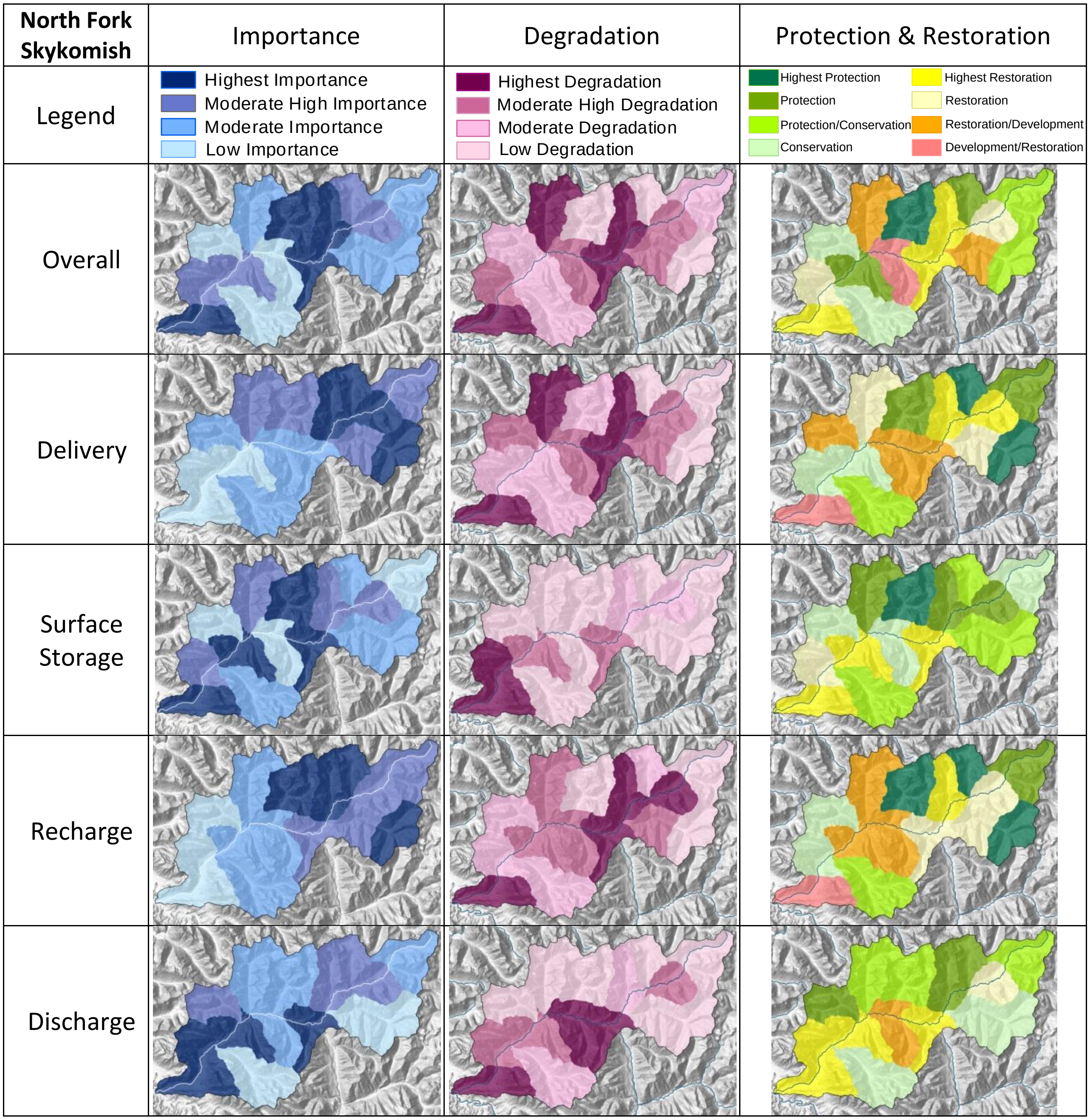



**Figure 107. Scale 3 water flow assessment results for the North Fork Skykomish River planning unit.**

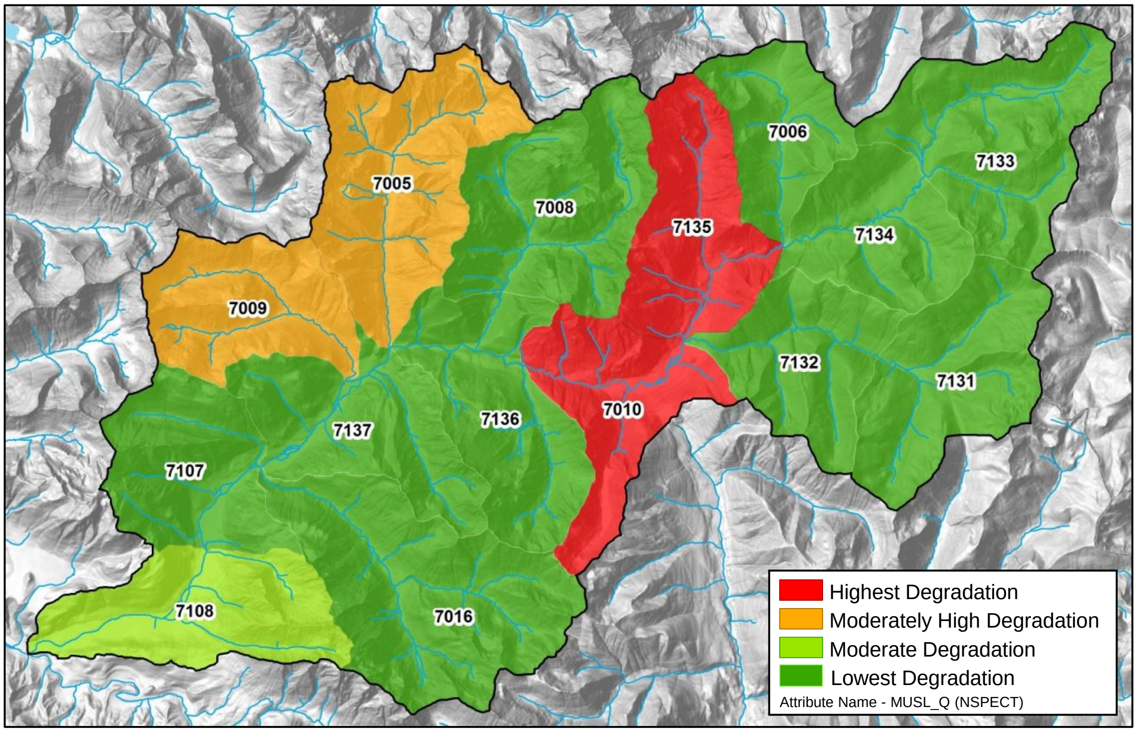



**Figure 108. Scale 1 results of sediment process degradation for the North Fork Skykomish River planning unit.**

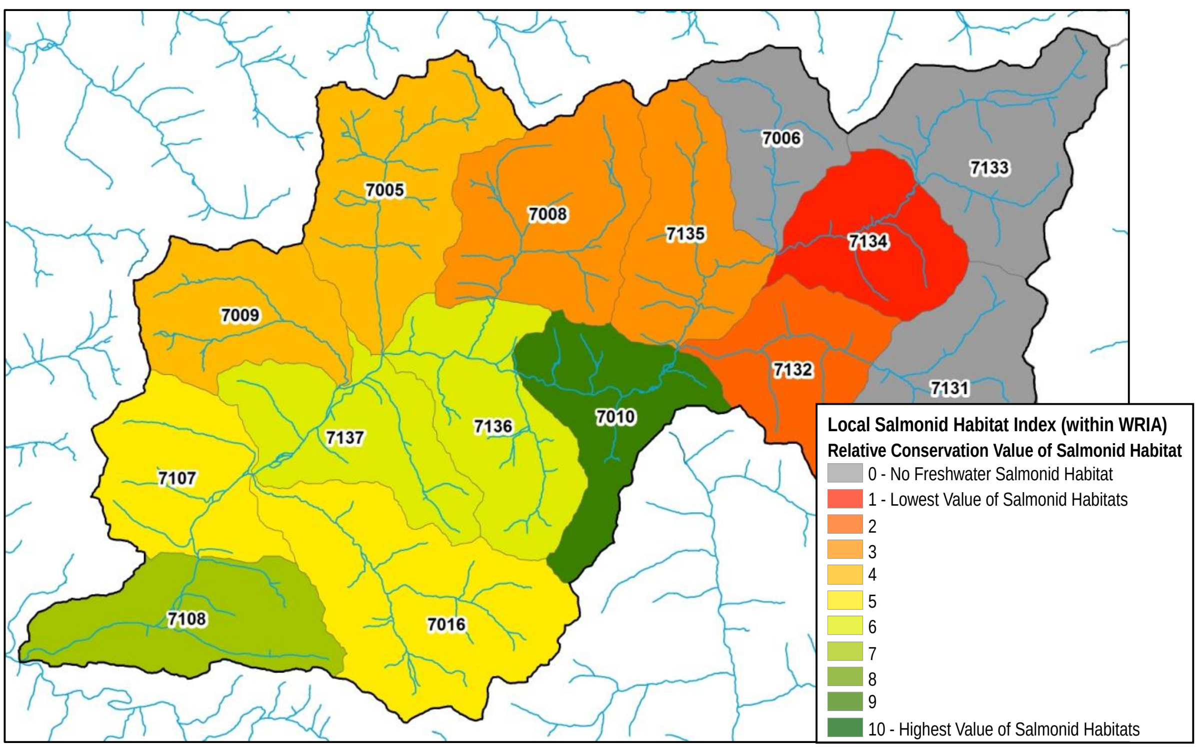



**Figure 109. Scale 1 results of the local salmonid habitat index (WHI) for the North Fork Skykomish planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 33 and Figure 110 provide an integrated look at the assessments for water flow (using scale 3 results), sediment process degradation (using WRIA 7 results, Figure 108) and salmonid habitats (WRIA 7 results, Figure 109) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or what factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 33 below brings in the scale 2 water flow recommendations for the Upper North Fork which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 33. Integration of assessment results for the North Fork Skykomish planning unit to identify priority AUs.**

<table>
<tr><td>Water Flow Importance</td><td>Water Flow Degradation</td><td>Water Quality Results – Sediment</td><td>Local Salmonid Habitats</td><td>Considerations</td></tr>
<tr><td>Highest ranked AUs in Planning unit (top 25%)<br><br>Overall water flow:<br>AUs around Troublesome creek and mainstem North Fork – 7008, 7010, 7108, 7135</td><td>Highest ranked (most degraded) AUs in planning unit (top 25%)<br><br>Overall water flow: 7005, 7010, 7108, 7135</td><td>AUs meeting cutoff (top 25%) threshold: 7010, 7135</td><td>AUs meeting habitat value cutoff (deciles 8-10) threshold:<br><br>7010</td><td>Priority AUs based on integration:
<table>
<tr><td colspan="2">Where?</td></tr>
<tr><td>Protection Group (AU id)</td><td>Restoration Group (AU id)</td></tr>
<tr><td>7008</td><td>(-)7010*, 7108, (-)7135</td></tr>
<tr><td colspan="2">What?<br>Management considerations</td></tr>
<tr><td>Highest priority AUs which have lower relative degradation in the planning unit.</td><td>Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) indicates high potential for degraded sediment processes which could undermine protection of salmonid habitats.*Indicates high relative salmonid habitat value in AU.</td></tr>
</table></td></tr>
<tr><td colspan="5">Basin Scale (2) considerations</td></tr>
<tr><td>Highest Ranked processes: recharge and delivery; one highest ranked AU for discharge</td><td>Highest Ranked (most degraded) processes): surface storage in lower watershed near mainstem Skykomish</td><td></td><td></td><td><u>Water flow</u><br>Scale 2 land use recommendation (restoration & protection): Highest Protection<br><br>Priority water flow processes to protect and restore: Protection of delivery, protection and restoration of recharge</td></tr>
</table>

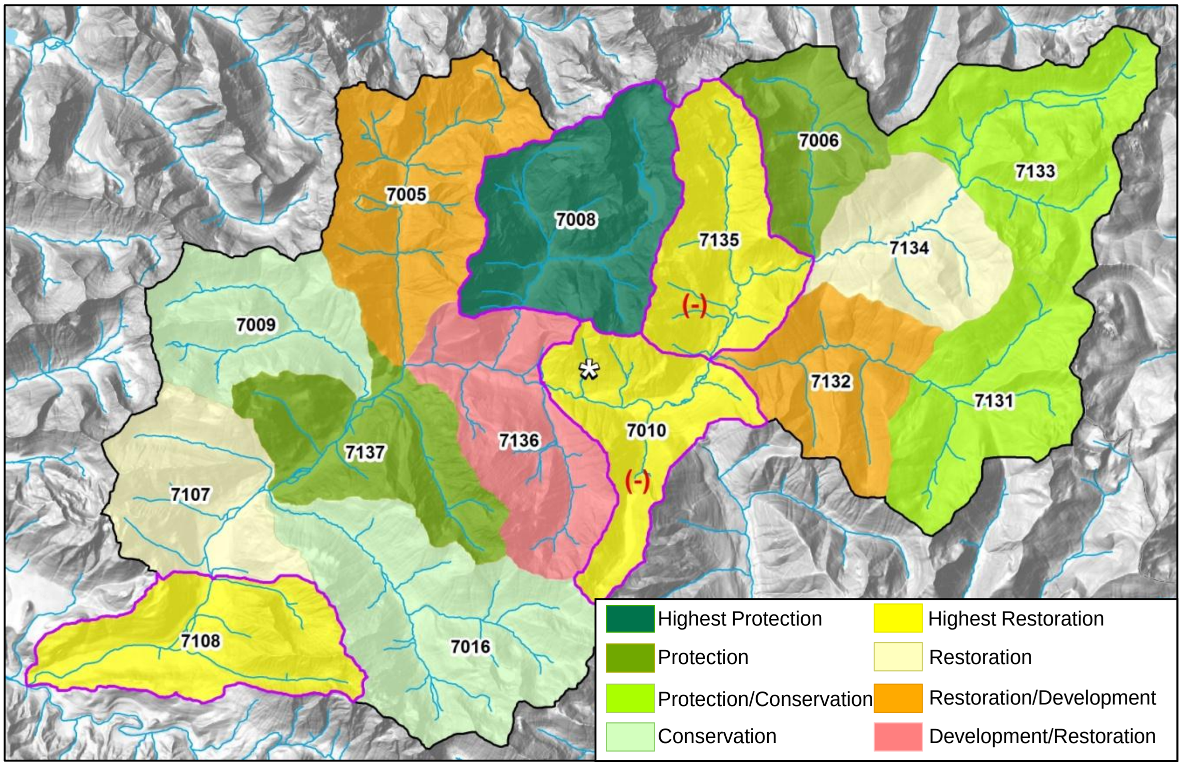



**Figure 110. Highest priority assessment units for protection of overall water flow processes in the North Fork Skykomish planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

## South Fork Skykomish Planning Unit

The South Fork Skykomish planning unit is comprised of the mainstem South Fork Skykomish River and its northern (Bechler River and Rapid River) as well as southern (Smith Creek Engle Creek, Foss River, Burn Creek) tributaries (Figure 111). In comparison to the rest of the Skykomish basin, the AUs in the South Fork Skykomish planning unit rank second highest for overall importance and second lowest for overall degradation to water flow processes (Table 18). As such, the *general land use recommendation is Protection and Restoration.*

Using the scale 2 results for the sub-components of the water flow process (Figure 35) we can target specific processes (delivery, surface storage, recharge, discharge) which may be considered as priority for protection and/or restoration based on the combination of an AUs relative importance and degradation. When assessing the South Fork Skykomish planning unit for predominant areas of highest importance to specific water flow processes, we can target the following:

Northern Tributaries: *Restore recharge, protect & restore delivery*
Southern Tributaries: *Protect recharge and delivery*
South Fork mainstem: *Restore surface storage*

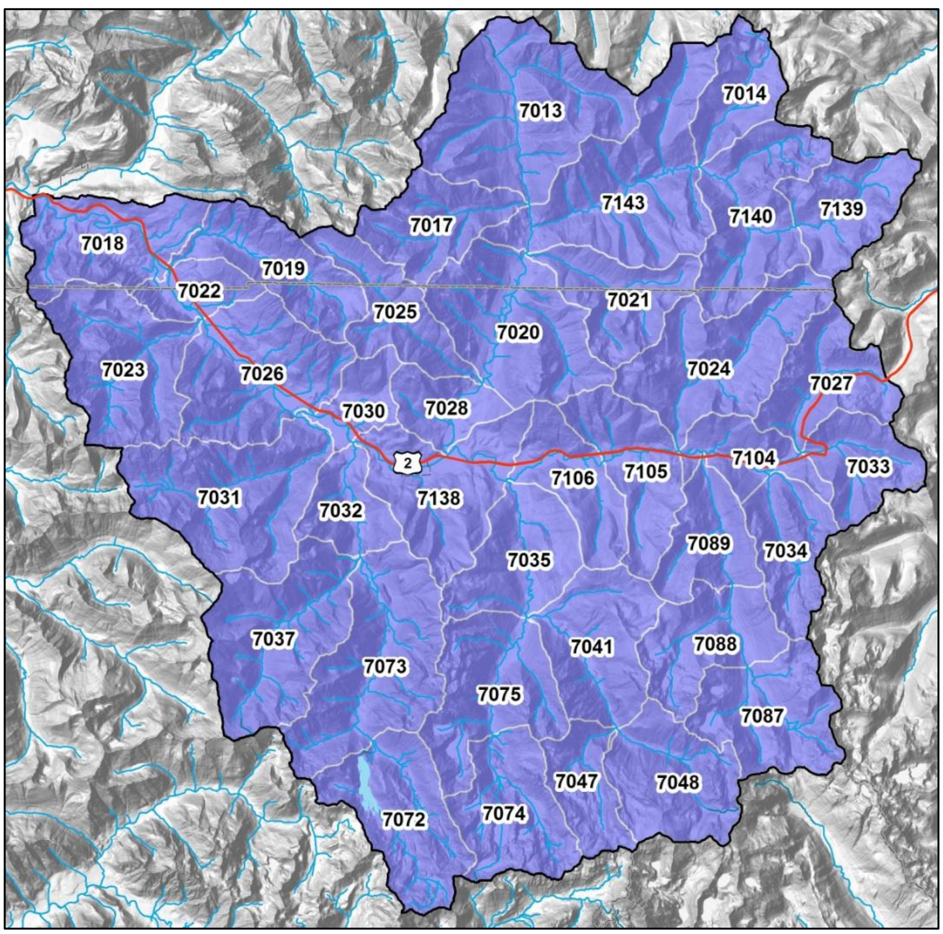



**Figure 111. The assessment units of the South Fork Skykomish planning unit.**

**Scale 3 water flow results**

The scale 3 water flow assessment for the South Fork Skykomish  planning unit uses the original AUs as their size and number provide an adequate comparison for the groupings based on combined importance and degradation scores (i.e. protection & restoration maps).  The scale 3 results presented below compare the same raw scores, but only among those AUs which lie within the planning unit, not to the rest of the larger basin (i.e. Lower Snohomish) or WRIA.  As a result, an AU may lie within the highest quartile (for importance or degradation) when viewing the scale 2 results, but may lie in a different quartile when viewing the scale 3 results because of the different relative comparisons.  The scale 3 assessment for the planning unit also presents a re-sorting of the AUs within the Management Matrix for water flow to help group the AUs to both their level of relative importance and relative degradation based upon the newly defined extent of comparison.

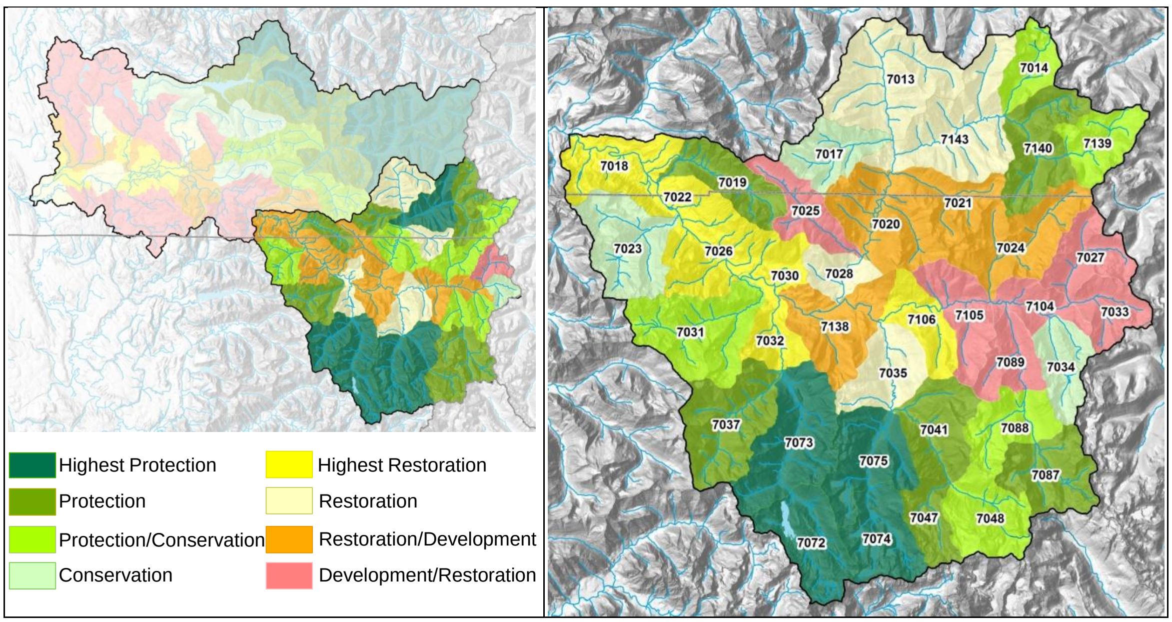



**Figure 112. Scale 2 (left) and scale 3 (right) overall water flow Protection & Restoration results for the South Fork Skykomish planning unit.**

The scale 3 assessment results (Figure 113) can be used to determine, specific to the South Fork Skykomish  planning unit, *where* to focus protection actions for water flow processes.  If an entity is prioritizing protection actions in the South Fork Skykomish planning unit that are attempting to address *all* water flow processes, consult the overall importance to water flow map to target specific AUs based upon their relative ranking.  If an entity is attempting to address specific water flow processes (i.e. delivery, surface storage, recharge or discharge) with their protection efforts, consult the sub-model results for that process.

If an entity is trying to determine *what (or which)* should be a priority water flow process to protect in the planning unit, the scale 2 results can help identify this, and then the scale 3 results can specifically target a selection of AUs (Figure 112). The WRIA 7 technical committee decided to identify and prioritize protection in the most important AUs, regardless of relative degradation.  So, the water flow degradation and Protection & Restoration maps for scale 3 are used to group priority AUs to provide information on potential impacts to water flow processes, *but do not indicate lower priority for protection in WRIA 7*.

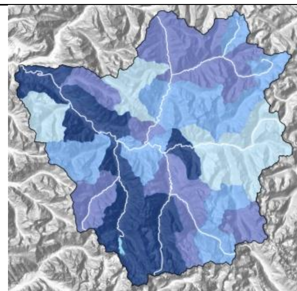
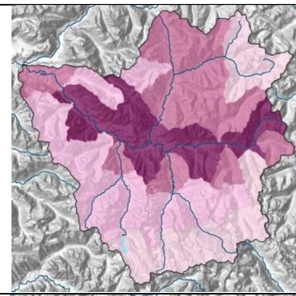
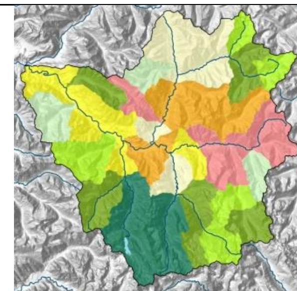
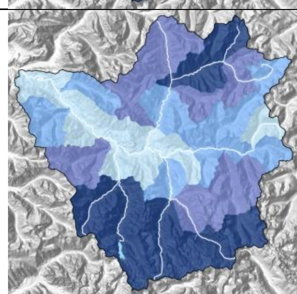
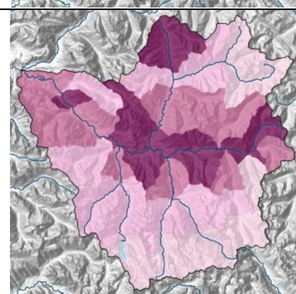
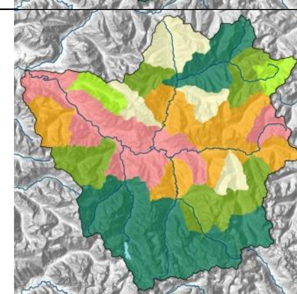
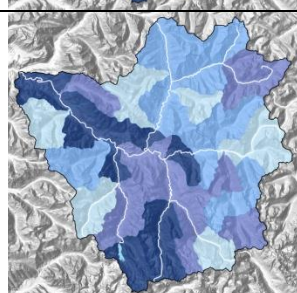
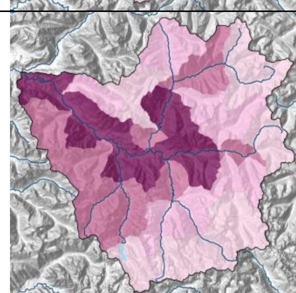
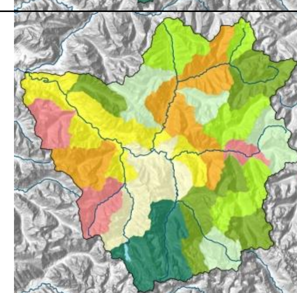
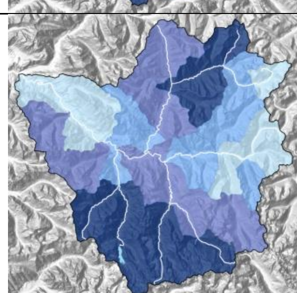
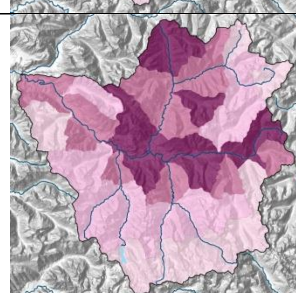
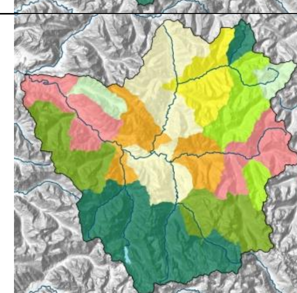
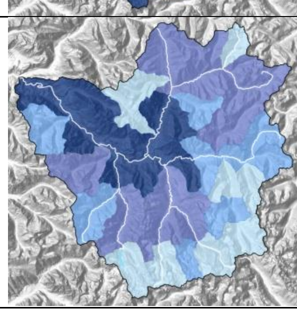
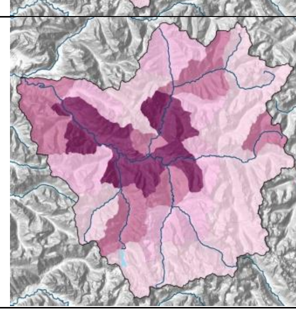
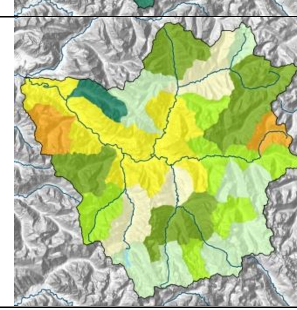
| South Fork Skykomish | Importance | Degradation | Protection & Restoration |
|---|---|---|---|
| Legend | Highest Importance<br>Moderate High Importance<br>Moderate Importance<br>Low Importance | Highest Degradation<br>Moderate High Degradation<br>Moderate Degradation<br>Low Degradation | Highest Protection<br>Protection<br>Protection/Conservation<br>Conservation<br>Highest Restoration<br>Restoration<br>Restoration/Development<br>Development/Restoration |
| Overall |  |  |  |
| Delivery |  |  |  |
| Surface Storage |  |  |  |
| Recharge |  |  |  |
| Discharge |  |  |  |

**Figure 113. Scale 3 water flow assessment results for the South Fork Skykomish.**

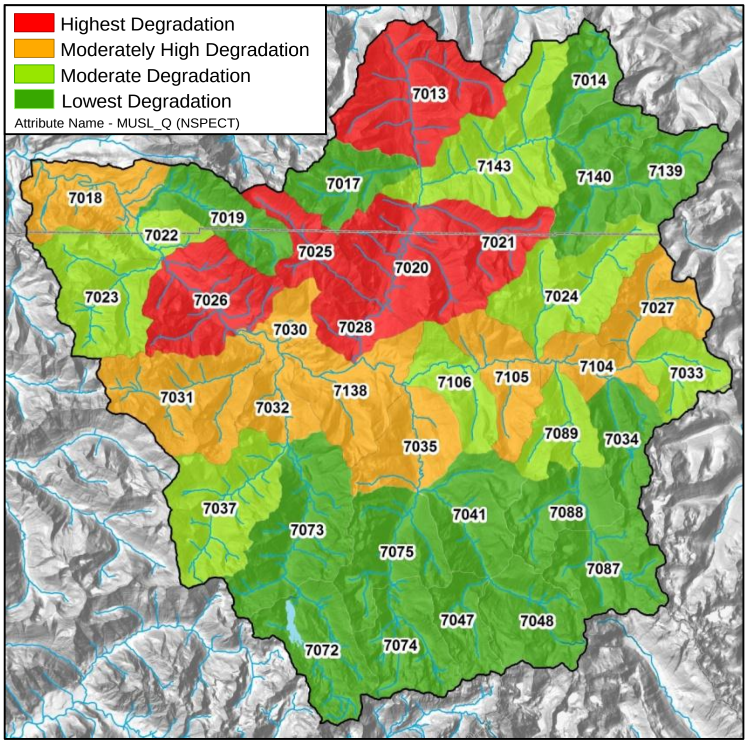



**Figure 114. Scale 1 results of sediment process degradation for the South Fork Skykomish planning unit.**

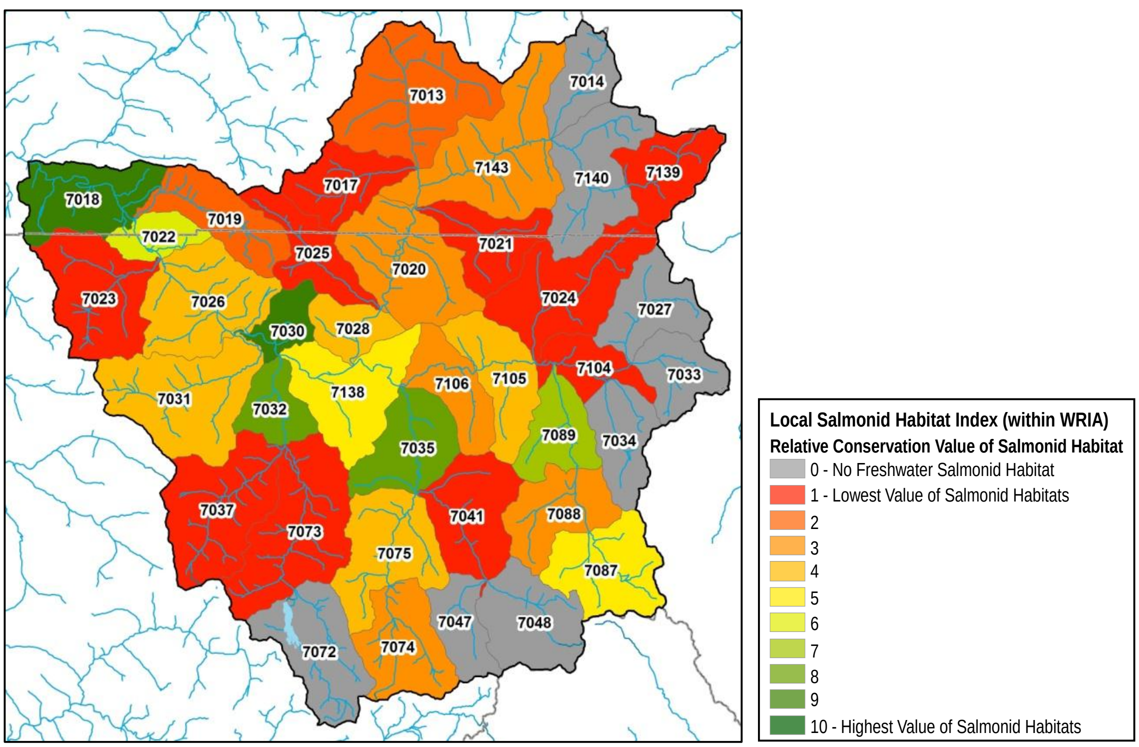



**Figure 115. Scale 1 results of the local salmonid habitat Index (WHI) for the South Fork Skykomish planning unit.** Index values divided into deciles: 10 is top 10% of values in WRIA and 1 is bottom 10%.

**Integrating assessments across scales to inform priority AUs for protection**

Table 34 and Figure 116 provide an integrated look at the assessments for water flow (using scale 3 results), sediment process degradation (using scale 1 WRIA 7 results, Figure 114) and salmonid habitats (using scale 1 WRIA 7 results, Figure 115) to identify a selection of AUs which may represent priority areas to focus protection efforts. This integration begins to answer the fundamental question of *where* an entity may wish to begin to prioritize efforts to protect hydrologic processes and generally *what* other benefits may be accrued, or what factors may hinder efforts based on the assessment for local salmonid habitat value and sediment process degradation.

Additionally, Table 34 below brings in the scale 2 water flow recommendations for the South Fork Skykomish planning unit, which can also be used to prioritize protection or restoration of different sub-components of the water flow processes and suggests overall land use which may be appropriate for the planning unit.

**Table 34. Integration of assessment results for the South Fork Skykomish planning unit to identify priority AUs.**

| Water Flow Importance | Water Flow Degradation | Water Quality Results – Sediment | Local Salmonid Habitats | Considerations |
|---|---|---|---|---|
| **Highest ranked AUs in Planning unit (top 25%)**<br><br>**Overall water flow**: generally in the mainstem and southern tributary AUs 7018, 7022, 7026, 7030, 7032, 7072, 7073, 7074, 7075, 7106 | **Highest ranked (most degraded) AUs in planning unit (top 25%)**<br><br>**Overall water flow**: Generally in the mainstem South Fork along highway 2 AUs 7022, 7025, 7026, 7027, 7028, 7030, 7104, 7105, 7106, 7138 | **AUs meeting cutoff (top 25%) threshold**: 7013, 7021, 7020, 7028, 7025, 7026 | **AUs meeting habitat value cutoff (deciles 8-10) threshold:**<br><br>7018<br>7030<br>7032<br>7035 | **Priority AUs based on integration:**<br>***Where?***<br>**Protection Group (AU id)**: 7072, 7074, 7073, 7075<br>**Restoration Group (AU id)**: 7022, (-)7026, 7030*, 7106, 7018*, 7032*,<br>***What?* Management considerations**<br>Protection Group: Highest priority AUs which have lower relative degradation in the planning unit.<br>Restoration Group: Highest priority AUs for overall water flow processes with higher relative levels of degradation in the planning unit. (-) Indicates that significant sediment process degradation could undermine habitat protection efforts for salmonids. * Indicates high relative salmonid habitat value in AU. |
| **Basin Scale (2) considerations** | | | | |
| **Highest Ranked processes**: recharge, delivery | **Highest Ranked (most degraded) processes**: Primarily recharge, though all subcomponents have AUs ranked highest in the planning unit. | | | **Water flow**<br>**Scale 2 land use recommendation**: Protection & Restoration<br><br>**Priority water flow processes to protect and restore**:<br>Northern Tribs: Restore recharge, protect & restore delivery<br>Southern Tribs: Protect recharge and delivery<br>South Fork mainstem: Restore surface storage |

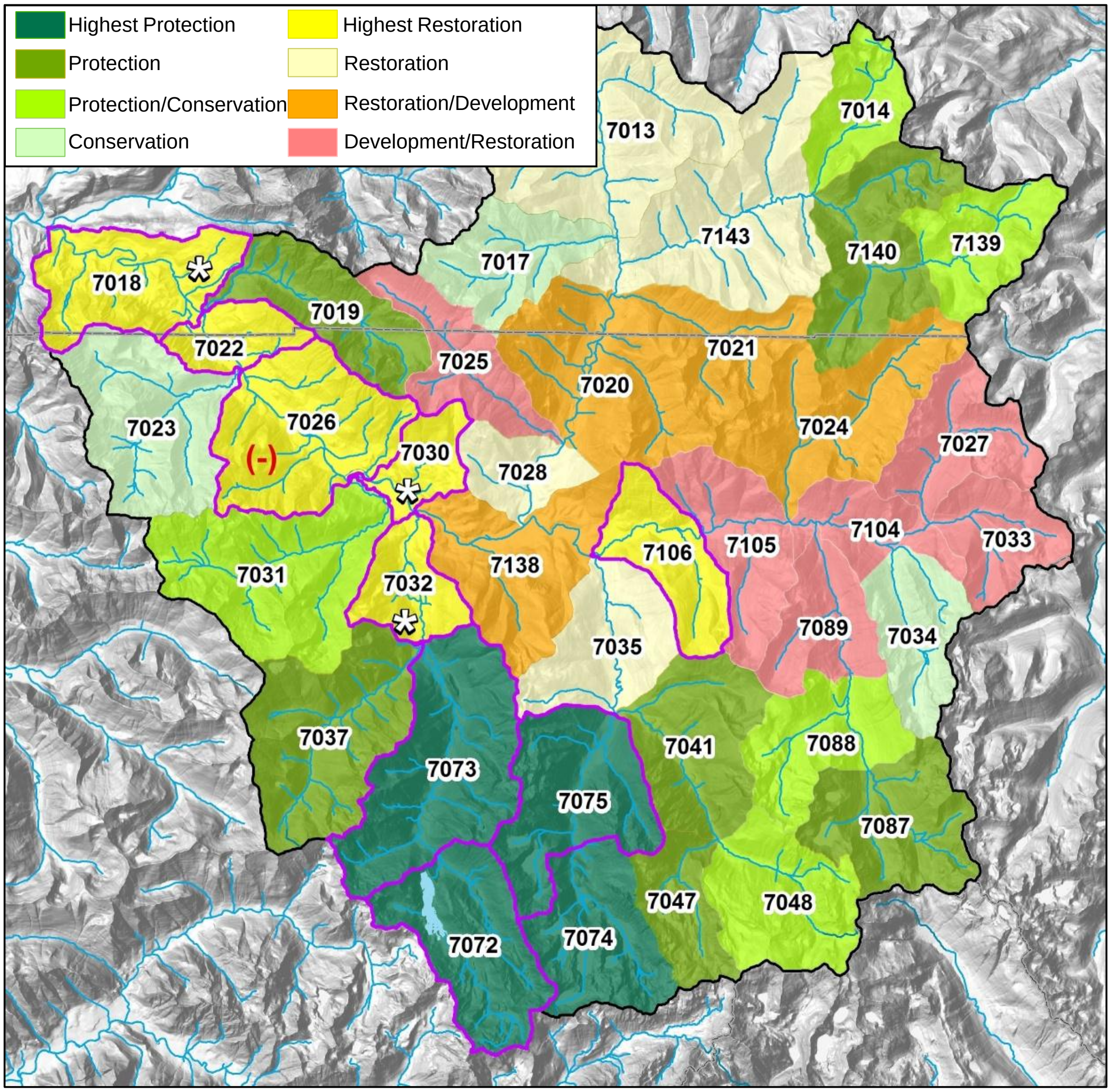



**Figure 116. Highest priority assessment units for protection of water flow processes in the South Fork Skykomish planning unit.** Purple outlined watersheds indicate the AU is in top 25% for overall importance to water flow processes. * indicates the AU meets the cutoff threshold for local salmonid habitats. (-) indicates the AU meets cutoff threshold for sediment process degradation.

# Works Cited

DeGasperi, C.L., H.B. Berg, K.R. Whiting, J.J. Burkey, J.L. Cassin, and R.R. Fuerstenberg. 2009. Linking hydrological alteration to bioilogical impairment in urbanizing streams of the Puget Sound lowland Washington, USA. Journal of the American Water Resources Association 45:512-533.

Failing, L., and R. Gregory. 2003. Ten common mistakes in designing biodiversity indicators for forest policy. Journal of Environmental Management 68:121-132.

Fleishman, E., D.D., Murphy, and P.F. Brussard. 2000. A new method for selection of umbrella species for conservation planning. Ecological Applications 10:569-579.

Mebane, C.A., T.R. Maret, and R.M. Hughes. 2003. An index of biological integrity (IBI) for Pacific Northwest rivers. Transactions of the American Fisheries Society 132:239-261.

Stanley, S., S. Grigsby, D.B. Booth, D. Hartley, R. Horner, T. Hruby, J. Thomas, P. Bissonette, R. Fuerstenberg, J. Lee, P. Olson, George Wilhere. 2011. Puget Sound Characterization. Volume 1: The Water Resources Assessments (Water Flow and Water Quality). Washington State Department of Ecology. Publication # 11-06-016. Olympia, WA.

Wilhere, G.F., T. Quinn, D. Govert, J. Jacobson, and A. Weiss. 2013. A Coarse-scale Assessment of the Relative Value of Small Drainage Areas and Marine Shorelines for the Conservation of Fish and Wildlife Habitats in Puget Sound Basin. Washington Department of Fish and Wildlife, Habitat Program, Olympia, Washington.