HABITAT ACTION PRIORITIZATION WITHIN THE UPPER COLUMBIA RIVER BASIN

UCRTT

UPPER COLUMBIA
REGIONAL
TECHNICAL TEAM

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Introduction

In this document, we describe a strategy for prioritizing protection1 and restoration[2] actions within the Upper Columbia River basin. We define prioritization as the process of ranking assessment units (AU),[3] reaches, limiting factors, and habitat action types[4] (for both restoration and protection) to determine their relative biological priority for funding and implementation. The reason for prioritization stems from the need to have the largest biological effects as soon as possible, to make the best use of limited resources, and to protect or restore areas before further degradation occurs. Prioritization is a critical component of the *Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region*, which was last updated in 2018. The objective of this strategy is to provide a consistent, repeatable, systematic, and well-documented approach for prioritizing restoration and protection action types and locations. This strategy will provide a transparent prioritization process that will assist restoration practitioners and managers with making decisions. We will revise this strategy periodically as new information becomes available, projects are completed, funding levels change, or new restoration and protection opportunities are identified.

In developing this strategy, we reviewed several programs including the BPA Atlas Process and other published studies (e.g., Williams et al. 2007 and Roni et al. 2013). Our approach consists of three important steps (Figure 1). The first step (Step 1) is prioritization of assessment units for restoration and protection. To do this, we used a standardized procedure to identify assessment units within each subbasin and identified metrics and scoring rules for prioritizing areas for restoration and protection. Step 1 outputs include a list of high priority assessment units for restoration and protection within each subbasin. The next step (Step 2) is identification of limiting life stages at the population and assessment unit scale, identification and ranking of limiting factors and threats that cause certain life stages to be limiting, identification and prioritization of reaches within AUs for restoration and protection, and identification and prioritization of habitat action types to address limiting factors. In both Steps 1 and 2,

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[1] Protection means any action or actions that maintain existing habitat or stop or curb habitat degradation (land acquisition and management).

[2] A wide variety of terms are used in the literature, including restoration, rehabilitation, mitigation, creation, improvement, and enhancement (NRC 1996; Roni and Beechie 2013). Although strictly speaking, restoration is defined as returning an ecosystem to its original, pre-disturbance state, in this document we use it synonymously with enhancement, rehabilitation, mitigation, creation, or improvement.

[3] An assessment unit (AU) is a portion of a watershed that consists of a similar ecoregion, geomorphology, and stream type. In this document, an AU is equivalent to a HUC 12 watershed.

[4] Action type refers to a classification of restoration actions such as pool development, riparian fencing, barrier removal, boulder placement, etc. Action types are classified under restoration categories such as protection, floodplain reconnection, riparian restoration, nutrient supplementation, etc. Table 6 identifies restoration categories and action types.

we developed scoring rules for each element and created a spreadsheet tool that calculates an overall combined score. These scores are used to rank habitat action types based entirely on biological benefit. Our partners, including the WATs and IT, provided input and reviews throughout the development of Steps 1 and 2.

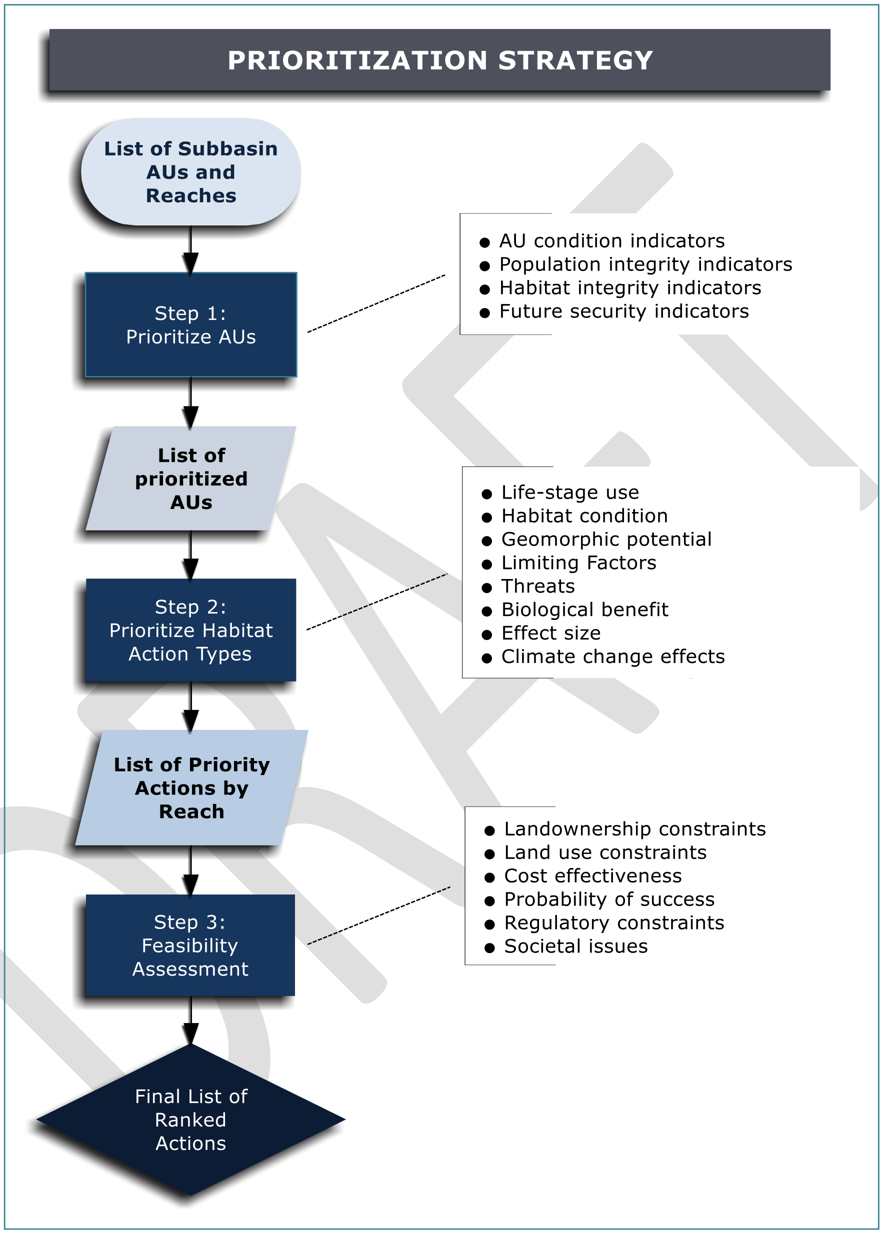

Figure 1. Three-step process for selecting habitat actions for restoration and protection.

The final step (Step 3) in the prioritization process is to support the WATs, IT, and others in determining the feasibility of implementing the prioritized list of action types within high priority areas. The final product will be a list of reach-specific, high-priority action types (restoration and protection) that if implemented should provide the greatest benefits to listed species[5]. Information will be contained on geospatial maps, hosted by the Upper Columbia Salmon Recovery Board, that will be available to funders and sponsors.

What follows is a description of the prioritization process. We first identify the spatial scale of the prioritization process and then describe each of the prioritization steps in detail. It is important to note that although this is an UCRTT product, prioritization is a collaborative process and its success is based on working closely with those involved with developing and implementing restoration and protection projects.

Spatial Scale

For the purposes of this strategy, the Upper Columbia River basin includes all tributaries between Priest Rapids and Chief Joseph dams (Figure 2). The basin consists of six, major "subbasins" (Crab, Wenatchee, Entiat, Chelan, Methow, and Okanogan basins) and several smaller watersheds. This area captures the distribution of the Upper Columbia River Basin Summer Steelhead (listed as endangered in 1997, reclassified as threatened in 2009, and updated again in 2014). It also captures the Upper Columbia River Spring Chinook Salmon Evolutionarily Significant Unit (ESU) (listed as endangered in 1999, updated in 2005, and then again in 2014) and the Upper Columbia Recovery Unit for the Columbia River Bull Trout Distinct Population (listed in 1998). The Interior Columbia Basin Technical Recovery Team identified independent populations of summer steelhead and spring Chinook within the Upper Columbia ESUs (ICBTRT 2003). They identified three independent populations of spring Chinook within the Upper Columbia ESU; Wenatchee, Entiat, and Methow populations. For summer steelhead, they identified five independent populations within the ESU; Wenatchee, Entiat, Methow, Okanogan, and Crab Creek populations. Although they identified five geographic areas for the independent populations of steelhead within the ESU, steelhead may also exist within smaller tributaries to the Columbia River, such as Squilchuck, Stemilt, Colockum, Tarpiscan, Tekison, Quilomene/Brushy, Palisade, Douglas, Foster, and Swakane creeks, and the Chelan River and tailrace.

[5] The focus of the prioritization process is on ESA-listed fish. However, the scoring runs can be modified to address other species such as Pacific lamprey.

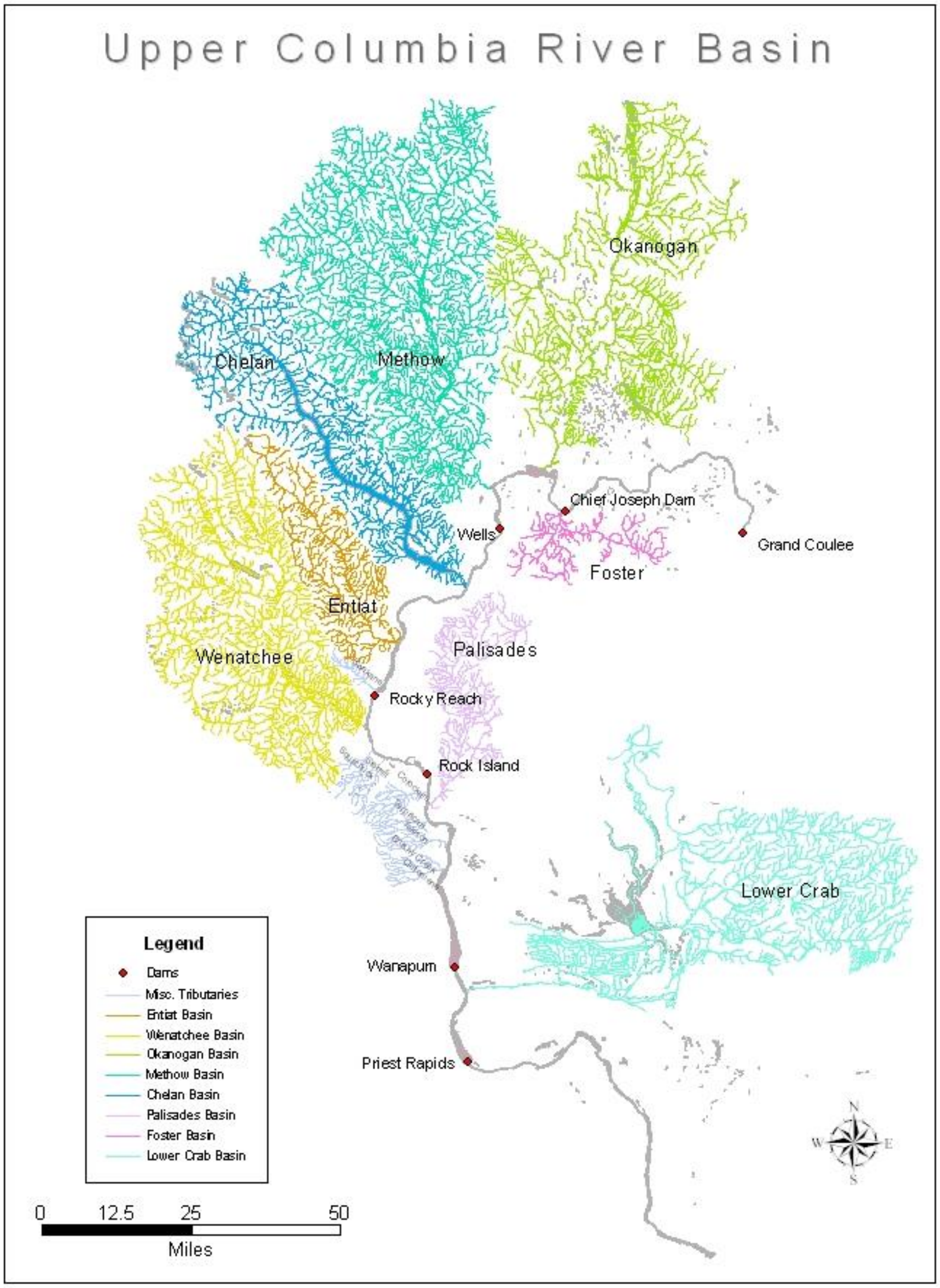

Figure 2. Tributaries in the Upper Columbia River Basin.

For prioritization, we will focus on the Wenatchee, Entiat, Methow, and Okanogan subbasins. Because of a lack of information, several of the smaller tributaries to the Columbia River and Crab Creek will receive less attention at this time. Once we have more information on the smaller tributaries to the Columbia River, we will include them in the prioritization process. In addition, because of the large amount of restoration work conducted by Chelan PUD in the Chelan River and Tailrace, this area will not be evaluated for prioritization at this time.

Importantly, this prioritization process does not rank populations or subbasins against each other for restoration or protection, because the four steelhead and the three spring Chinook populations must each reach recovery levels for delisting under the ESA.[6] Rather, this process prioritizes assessment units and reaches within each population or subbasin. That is, the process will rank assessment units and reaches within the Wenatchee subbasin independently of assessment units and reaches within the Methow subbasin. Thus, each subbasin will have its own list of priority areas and actions for protection and restoration.

Prioritization Approach

As noted above, we identified a three-step process for prioritizing restoration and protection actions. Step 1 involves ranking assessment units within each subbasin (i.e., Wenatchee, Entiat, Methow, and Okanogan) for restoration and protection. Step 2 involves identifying limiting factors, threats, limiting life stages, and geomorphic potential within the assessment units. From this, we rank reaches within AUs for restoration and protection, and identify and rank habitat action types that will address the threats, limiting factors, and limiting life stages, and fit within the geomorphic processes that shape the stream channel. Step 3 involves refining the ranking of restoration and protection actions within each reach based on feasibility. At this step, factors such as landowner willingness, cost, complexity, and societal issues[7] come into play. As noted above, the RTT will support the WATs, IT, and others in developing the third step. In sum, the three-step process includes biological, physical, economic, and sociopolitical criteria.

We understand there are several different approaches that can be used to prioritize restoration and protection actions in the Upper Columbia River basin. We selected the three-step approach because it is simple, repeatable, systematic, and transparent, and can be used throughout the Upper Columbia region. However, we acknowledge the extensive development and use of the Ecosystem Diagnosis and Treatment (EDT) model in the Okanogan River basin (and recently completed within the Methow River basin), where prioritization was developed around EDT. It is not our desire to replace the EDT work with the prioritization approach described in this document. Rather, we encourage the use of the EDT model to prioritize restoration and protection actions and assessment units where the model has been extensively developed and used. However, where EDT is not up-to-date or well developed (e.g.,

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[6] If a given population moves closer to extinction, we will then prioritize among populations.

[7] Examples of societal issues include conflicts between enhancement opportunities and recreational, political, and economic issues. The latter may include, for example, conflicts between beaver reintroduction and agricultural practices.

Wenatchee and Entiat subbasins), we need a prioritization strategy that will accommodate the best available information, whether it comes from EDT or other sources. Thus, this strategy is designed to use EDT results if they are available, but it does not require EDT. Below we describe the three-step process in more detail.

Step 1: Assessment Unit Prioritization

Modeling efforts indicate that to produce measurable increases in salmon and trout abundance at a watershed or population scale, a large amount of habitat within a watershed needs to be enhanced, suggesting the need to focus limited resources on watersheds or assessment units with the largest potential for fish recovery and restoration (Roni et al. 2010). Thus, the first step in the prioritization process is to rank HUC12 sub-watersheds ("assessment units") within each subbasin for restoration and prioritization. This will be accomplished by using a multi-criteria decision analysis (MCDA) framework, similar to that used by Williams et al. (2007) to rank watersheds for protection of endangered trout. The MCDA includes specific indicators for Assessment Unit Condition, Population Integrity, Habitat Integrity, and Future Security and is developed for each listed species (spring Chinook, steelhead, and bull trout) (see Attachment 1 for more details). Based on an evaluation of the literature and input from the IT, WATs, project implementers, and others, we identified the following indicators for each category:

- Assessment Unit Condition Indicators
    - Intrinsic Potential – Length of total intrinsic potential, occupied intrinsic potential, and unoccupied intrinsic potential within an assessment unit.
    - Spawning Area Designation – Designation of assessment unit as a major (MaSA) or minor (MiSA) spawning area (salmon and steelhead) or spawning and rearing (SR) habitat (bull trout) in the respective recovery plan.
- Population Integrity Indicators
    - Life-Stage Use – Number of life stages present within an assessment unit.
    - Spawner Abundance – Spawning escapement within an assessment unit.
- Habitat Integrity Indicators
    - Habitat Quality – Habitat quality for adult holding, spawning/incubation, summer rearing, and winter rearing (see Attachment 1 for a listing of factors used to assess habitat quality).
    - Degraded Habitat – Percent of the assessment unit altered by land-use activities.
- Future Security Indicators
    - Climate Change – Area of assessment unit sensitive to climate change (Beechie et al. 2012; Crozier 2016).
    - Land Stewardship – Percent of the assessment unit in a protected status.
    - Non-native Fish Species (bull trout only) – Presence of brook trout within an assessment unit with bull trout spawning.

These indicators will be used to score and rank assessment units for spring Chinook salmon, steelhead, and bull trout for both restoration and protection.

Based on the literature, Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, monitoring data, and our scoring criteria for evaluating proposed projects, we identified a consistent range of scores for each indicator (see Attachment 1). For each indicator, scores range from 1 to 5, with 5 being the preferred condition. The definition of each score depends on the species and whether we are prioritizing for restoration or protection. The scores are defined such that overall scores rank assessment units by species from highest to lowest for both restoration and protection. Because some indicators may be more important than others in ranking assessment units, those important indicators will be given greater weight than others. A different set of weights will be assigned to indicators for different species and for restoration and protection.

The final step is to summarize the scores for each assessment unit, each species, and for protection and restoration. This is accomplished by summing the product of each indicator score by its weight. Total scores are then sorted from highest to lowest for each species and for protection and restoration. This is a simple and transparent way to rank assessment units for protection and restoration. The resulting table of information (which can be found at www.ucsrb.org) provides indicator data, individual indicator scores, indicator weights, and total scores by species. The RTT will regularly review and update the tool.

EDT Modeling

The current EDT model in the Okanogan and Methow basins will provide output that accounts for most of the indicators identified in Step 1. For areas with EDT, we will:

1. Rank each Assessment Unit based on observed adult and juvenile abundance.
2. Calculate an EDT protection and restoration priority rank for each Assessment Unit using EDT capacity, productivity, and life-history diversity metrics.
3. Sum ranks to produce an integrated habitat protection and restoration priority score for each assessment unit.

Step 2: Habitat Action Type Prioritization

The second step of the prioritization process is to rank habitat restoration and protection actions within high-priority assessment units and reaches. This will be accomplished by first identifying the limiting life stages at the population scale and the AU scale. We will then identify the factors that affect the limiting life stages. This work will occur at the reach scale and will include identifying the threats, which are activities or processes that cause certain habitat conditions to be limiting to fish (e.g., roads, logging, mining, landslides, etc.). We will then rank reaches within each AU for restoration and protection based on limiting factors and restoration or protection potential. Lastly, we will identify and prioritize habitat action types based on their ability to influence limited life stages and limiting factors within priority reaches.

Working with our partners (WATs, IT, and others), we will use life-cycle modeling, watershed assessments, reach assessments, habitat modeling (e.g., EDT, WUA, etc.), riparian assessments, remote sensing information (e.g., Light Detection and Ranging, aerial photos, etc.), status and trend monitoring data, Expert Panel information, and professional judgment to inform this step. These tools will be used to identify spatially explicit degraded and properly functioning habitat conditions. These conditions, including limiting factors and threats will be mapped using geographic information system (GIS) technology. Specifically, they will be included on the GIS maps showing the standardized assessment units and reaches. All this information will then be evaluated to identify appropriate restoration action types, which will also be mapped in GIS. With this information, we then rank restoration action types for each priority reach and rank reaches for protection. Below we describe each element of this step.

Step 2a: Identification and Prioritization of Life Stages

The first exercise under Step 2 is to identify and prioritize limiting life stages within populations and assessment units for each species (i.e., spring Chinook, steelhead, and bull trout). Life stages include Adult Migration, Maturation/Holding, Spawning/Incubation, Summer Rearing, Winter Rearing, and Smolt Emigration and are defined as follows:

- **Adult Migration** – adult fish are moving through an area to spawn in an upstream AU (AUs at the terminus of the spawning distribution do not have adult migration).
- **Maturation/Holding** – adults spending an extended period of time (days to weeks to months) in an area (requires adequate flow and temperature during holding period).
- **Spawning/Incubation** – spawning occurs in the AU.
- **Summer Rearing** – (April-September) low flow and high temperature habitat for fry and juveniles.
- **Winter Rearing** – (October-March) low temperatures (<10°C) and often low flows.
- **Smolt Emigration** - smolts are moving downstream through an AU to migration to the ocean (only AUs downstream of areas that have winter habitat upstream have smolt emigration).

At this stage, we will use life-cycle models, watershed assessments, reach assessments, monitoring data, the current Biological Strategy, Expert Panel process, and other sources to identify life stages that limit population performance. Each life stage is then scored based on its effect on local (AU) and population production. There are separate scoring rules for restoration (Table 1) and protection (Table 2).

Table 1. Scores for ranking life stages within each assessment unit (HUC 12) for restoration.

Limiting life-stage score	Definition
-9999	Missing data on this life stage
0	AU did not and will not support the life stage
1	Life stage is a low priority for restoration work
2	Life stage is a medium priority for restoration work
3	Life stage is a high priority for restoration work

Criteria for determining "low," "medium," and "high" priority for restoration are as follows:

<u>Low Priority (1)</u>

- Life stage is present but not limiting productivity.
- Life stage is NOT present and there is little opportunity to provide capacity.
- Life stage is present but there is little opportunity to provide capacity.
- Life stage is present but there is relatively little use by this life stage.

<u>Medium Priority (2)</u>

- Life stage not present or at low abundance but restoration could provide additional capacity.
- Life stage is present but it is only moderately limiting productivity.
- Life stage is presumed to be important but data are limited on how much it affects productivity.
- Not a low priority and not a high priority (Goldilocks Principle).

<u>High Priority (3)</u>

- Life stage is present and is known or presumed to be limiting productivity.

Table 2. Scores for ranking life stages within each assessment unit (HUC 12) for protection.

Limiting life-stage score	Definition
-9999	Missing data on this life stage
0	AU did not and will not support the life stage
1	Life stage is a low priority for protection
2	Life stage is a medium priority for protection
3	Life stage is a high priority for protection

Criteria for determining "low," "medium," and "high" priority for protection are as follows:

<u>Low Priority (1)</u>

- Life stage habitat is already protected.
- Protection would not substantially affect productivity or survival of the Life stage.

- AU or population suggests that the life stage is not limiting productivity.
- Life stage is NOT present and there is little opportunity to provide capacity for that Life stage.
- Life stage is present but there is relatively little use by this life stage.

Medium Priority (2)

- Life stage not present or at low abundance but restoration could provide additional capacity.
- Life stage is present but it is only moderately limiting productivity.
- Life stage is presumed to be important but data are limited on how much it affects productivity.
- Not a low priority and not a high priority (Goldilocks Principle).

High Priority (3)

- Life stage is present and is known or presumed to be limiting productivity at the AU or population scale.
- Protection efforts would substantially benefit a life stage that is limiting.
- Protection efforts would protect highly important habitat for a limiting life stage.

Step 2b: Identification and Prioritization of Limiting Factors and Threats

The next phase under Step 2 is to identify and prioritize the factors and threats that affect the limiting life stages at the reach scale. Here, we use available information from reach assessments, watershed assessments, limiting factors analysis, monitoring programs, modeling work, the current Biological Strategy, Expert Panel process, and other sources to identify factors and threats that limit population performance. Limiting factors are then scored based on their effect on critical life stages and salmonid performance (Table 3).

Table 3. Scores for ranking limiting factors within each reach.

Limiting factor score	Definition
1	Factors that may be beneficial to address but will have limited effects on critical life stages or population performance.
3	Factors that will have moderate effects on critical life stages and population performance.
5	Factors that are necessary to address critical life stages and population performance.

Importantly, factors that are lethal (e.g., lethal temperatures and other water quality issues, no flow, etc.) must be addressed before other factors are evaluated. Thus, lethal factors serve as an "on/off" switch for restoration. If lethal factors are present ("on"), only those are evaluated; if lethal factors are not present ("off"), all limiting factors are evaluated.

After limiting factors are identified and ranked, threats that cause factors to be limiting will be identified. Both limiting factors and threats will be mapped using GIS technology for each assessment unit. This information will be used to help identify appropriate enhancement action types for each reach within the assessment units.

Step 2c: Prioritization of Reaches

Once limiting factors and threats are identified, we will prioritize reaches for both restoration and protection based on fish periodicity (temporal presence/absence) and life-stage use, habitat condition, and geomorphic potential. Fish presence will be described for each focal species (Chinook salmon, steelhead, and bull trout) at seven life stages (Adult Migration, Maturation and Holding, Spawning/Incubation, Fry, Summer Rearing, Winter Rearing, and Smolt Emigration). For each reach, we will prepare presence/absence tables and then count the number of life stages and species present within each reach (Table 4). The length of time a given life stage is present within a reach is not a factor in determining periodicity. Chinook salmon will be given more weight than steelhead and bull trout, because Chinook are listed as Endangered, while steelhead and bull trout are listed as Threatened. Reaches that have more life stages and multiple species receive the highest scores.

Table 4. Example of a fish periodicity (presence/absence) table. Colored cells indicate presence; lighter shades indicate limited use.

Pucker Brush Creek in Assessment Unit PB1; Reach PBR1																									
Species	Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
		1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
Chinook salmon	Adult migration																								
	Adult holding																								
	Adult spawning																								
	Incubation/emergence																								
	Juvenile summer rearing																								
	Juvenile winter rearing																								
	Juvenile emigration																								
Steelhead	Adult migration																								
	Adult holding																								
	Adult spawning																								
	Incubation/emergence																								
	Juvenile summer rearing																								
	Juvenile winter rearing																								
	Juvenile emigration																								
Bull trout	Adult migration																								
	Adult holding																								
	Adult spawning																								
	Incubation/emergence																								
	Juvenile summer rearing																								
	Juvenile winter rearing																								
	Juvenile emigration																								

Fish use is based on the number of important life stages present within a reach and their ranking as determined from fish-use scores. Using the best available information, we assign habitat-use scores based on how important a life stage is to population performance (abundance, productivity, and viability) within a given reach (Table 5). For restoration, reaches with the most life stages present and in need of immediate action for population performance receive the highest scores. For protection, reaches with the most life stages present and with the best habitat conditions receive the highest scores.

Table 5. Scores for current fish use for restoration and protection within each reach.

Habitat-use score	Definition
Restoration	
0	Life stage is not present.
1	Life stage use is minimally affected by current conditions.
3	Life stage use is important to *long-term* population performance.
5	Life stage use needs *immediate* action for population performance.
Protection	
0	Life stage is not present.
1	Life stage use needs action for population performance.
3	Life stage use is important to *long-term* population performance.
5	Life stage use is minimally affected by current conditions.

Habitat condition reflects the current condition of habitat within a reach and the potential for habitat improvement. For restoration, scores are based on the assumption that reaches with fair to good habitat conditions provide the most opportunity for improvement (thus, the highest scores), while areas with poor habitat would require larger resource investments for minimal improvement, and reaches with excellent habitat provide little opportunity for improvement (Table 6). For protection, reaches with good to excellent habitat conditions receive the highest scores.

Table 6. Scores for habitat condition for restoration and protection within each reach. Properly functioning condition can be estimated using habitat models, reach assessments, and/or from the Expert Panel process.

Habitat condition score	Definition
Restoration	
1	Habitat condition is at ≤10% properly functioning condition.
2	Habitat condition is at >90% properly functioning condition.
3	Habitat condition is at 11-40% properly functioning condition.
4	Habitat condition is at 61-90 properly functioning condition.
5	Habitat condition is at 41-60% properly functioning condition.
Protection	
1	Habitat condition is at ≤10% properly functioning condition.
2	Habitat condition is at 11-40% properly functioning condition.
3	Habitat condition is at 41-60% properly functioning condition.
4	Habitat condition is at 61-90 properly functioning condition.
5	Habitat condition is at >90% properly functioning condition.

Geomorphic potential reflects the ability of actions to affect habitat conditions based on valley confinement. Scoring assumes that moderately confined or unconfined reaches offer more process-based enhancement opportunities than confined reaches (Table 7). Intrinsic potential maps, Beechie Classification, and other data inform this metric.

Table 7. Scores for geomorphic potential within each reach.

Geomorphic score	Definition
1	Little to no floodplain available for enhancement (confined reach).
3	Moderate amount of floodplain available for enhancement (moderately confined).
5	Large amount of floodplain available for enhancement (unconfined reach).

Each of the metrics used to prioritize reaches (fish periodicity, habitat use, habitat condition, and geomorphic potential) are weighted equally; i.e., each metric constitutes 25% of the composite score. A composite score for each reach is generated by summing the score of each metric. Total scores are then sorted from highest to lowest, reflecting the ranking of reaches within AUs for enhancement work and protection.

Step 2d: Prioritization of Habitat Action Types

Following the prioritization of reaches for restoration and protection, we will then identify and prioritize appropriate restoration and protection action types within each priority reach. Specific restoration action types will be grouped into ten broad categories (Table 8). The specific action types are intended to provide a comprehensive list of potential activities that might be implemented to address limiting factors, threats, salmonid life stages, and geomorphic conditions. They include both passive and active restoration approaches and include activities that range from site-specific actions to watershed-scale actions.

Table 8. List of restoration categories and action types.

Category	Action types
Protection	Acquisition
	Easement
Channel modification	Channel reconstruction or construction
	Pool development
	Riffle construction
	Meander (oxbow) reconnection or construction
	Spawning gravel cleaning or placement
Floodplain Reconnection	Levee modification: removal, setback, breach
	Remove or relocate floodplain infrastructure
	Restoration of floodplain topography and vegetation
	Floodplain construction
Side Channel/Off-Channel Restoration	Perennial side channel
	Secondary (non-perennial) channel
	Floodplain pond – wetland
	Alcoves
	Hyporheic off-channel habitat (groundwater)
	Beaver restoration management

Category	Action types
Riparian Restoration and Management	Riparian fencing
	Riparian buffer strip, planting
	Thinning or removal of understory
	Removal of non-native plant species
Fish Passage Restoration	Dam removal or breaching
	Barrier or culvert replacement or removal
	Structural passage (diversions)
Nutrient Supplementation	Addition of organic or inorganic nutrients
Instream Structures	Rock weirs
	Boulder placement
	LWD placement and engineered log jams
Bank Restoration, Modification, and Removal	Modification or removal of bank armoring
	Restore banklines with LWD - bioengineering
Water Quality and Quantity	Acquire instream flows (lease or purchase)
	Improve thermal refugia
	Irrigation system upgrades – water management
	Reduce or mitigate point-source effects
	Upland vegetation treatment – management
	Road decommissioning or abandonment
	Road grading and drainage improvements

Once appropriate action types are identified within priority reaches, we will then rank the action types. In some cases, a combination of action types (e.g., levee removal and riparian planting) may be needed and those will be ranked as one composite action type. Below we describe the process of ranking restoration action types and reaches for protection.

<u>**Restoration Actions**</u>: Based on our scoring criteria for evaluating restoration project proposals, we identified four indicators for ranking habitat actions within priority reaches (Table 9).

Table 9. Indicators and scores for prioritizing restoration actions within each reach. Benefits refer to fish.

Indicators	Score	Definition
Benefit (Roni et al. 2002; 2013)	1	Action will provide no immediate (<10 yrs) or long-term benefit (>50 yrs).
	3	Action will provide some immediate benefit but no long-term benefit.
	5	Action will provide immediate and long-term benefit.
Improves natural processes (Beechie et al. 2010)	1	Action does little to promote natural processes within the reach.
	3	Action partially improves natural processes within the reach.
	5	Action fully restores natural processes within the reach.
Size of action effect	1	Action addresses <30% of the limiting factor within the reach.
	3	Action addresses 30-70% of the limiting factor within the reach.

Indicators	Score	Definition
	5	Action address >70% of the limiting factor within the reach.
Ameliorates climate change effects (Beechie et al. 2012)	1	Action will not ameliorate the effects of climate change.
	3	Action will partially ameliorate the effects of climate change.
	5	Action will ameliorate the effects of climate change.

Indicators will be weighted based on their overall importance. Total scores will be calculated by summing the product of each indicator score by its weight. These scores will then be sorted from highest to lowest, with the highest scores indicating highest priority projects.

<u>Protection Actions</u>: Based on our scoring criteria for evaluating protection project proposals, we identified six indicators for ranking reaches for protection (Table 10). This level of ranking further refines the prioritization of reaches described above.

Table 10. Indicators and scores for prioritizing reaches for protection.

Indicators	Score	Definition
Ownership	1	Reach is entirely on public lands.
	3	Reach is a mix of private and public lands.
	5	Reach is entirely on private lands.
Size of area to be protected	1	Area to be protected makes up <30% of the reach.
	3	Area to be protected makes up 30-70% of the reach.
	5	Area to be protected makes up >70% of the reach.
Connection with other protected areas	1	Area to be protected is disconnected with other protected parcels.
	3	Area to be protected is partially connected with other protected parcels.
	5	Area to be protected is completely connected with other protected parcels.
Risk of degradation	1	There is no risk that the area will be degraded.
	3	There is an intermediate or unknown risk that the area will be degraded.
	5	There is a high risk that the area will be degraded.
Presence of upstream degradation	1	Extensive degradation upstream will degrade the area to be protected.
	3	Degradation upstream will have intermediate effects on the area to be protected.
	5	There is no degradation upstream that will degrade the area to be protected.
Sustains natural processes	1	Area to be protected does not sustain natural processes.
	3	Area to be protected partially sustains natural processes.
	5	Area to be protected sustains natural processes.

Indicators will be weighted based on their overall importance. Total scores will be calculated by summing the product of each indicator score by its weight. These scores will then be sorted from highest to lowest, with the highest scores indicating highest priority projects.

EDT Modeling

The current EDT model in the Okanogan and Methow basins will provide output that accounts for most of the indicators identified in Step 2. For areas with EDT, we will use:

1. Percent of template function: Current limiting factor performance relative to the EDT template in the Assessment Unit.
2. Relative weight: The proportion of negative productivity impacts relative to the EDT template that are attributable to the limiting factor in the Assessment Unit.
3. Template abundance: Adult abundance potential in the Assessment Unit under template conditions.

These parameters are combined to produce a limiting factor priority score using the following equation:

$$Priority\ Score = \frac{pT}{W} * TNeq$$

Where: *pT* = Percent of template function

W = Relative weight

TNeq = Template adult abundance

This formula produces an individual priority score for each limiting factor by Assessment Unit that reflects its importance relative to all other limiting factors across Assessment Units. It considers the current condition of each limiting factor, the potential improvements in habitat performance with restoration, and the overall restoration potential of each assessment unit. The priority scores can range across three to four orders of magnitude, allowing the user to easily differentiate which limiting factors are most important.

Step 3: Feasibility Assessment

Results from Steps 1 and 2 provide high priority action types within high priority reaches and AUs based on biological benefit. To this point, feasibility of implementing projects has not been considered. In the final step in the prioritization process, we will provide support to the WATs, IT, and others in assessing the feasibility of implementing the ranked restoration and protection actions. Using the prioritized list of restoration and protection actions for each priority reach, the WATs, IT, and others will evaluate feasibility using the following possible indicators:

- Landowner Willingness – Landowner willingness may preclude the implementation of certain action types within an assessment unit. This criterion applies to private lands within the assessment unit.

- Public Willingness – Members of the community may object to proposed actions on public lands if the proposed actions interfere with other public activities (e.g., members of the community may object to road decommissioning if it reduces motorized recreational opportunities).
- Land-use Constraints – Current infrastructure such as roads/railways, businesses, homes, etc. may preclude implementation of certain action types.
- Cost Effectiveness – The cost of an action relative to its benefit may reduce the ranking of an action type (Box 4.1 on pages 113-114 in ISAB (2018) provides a simplified framework for evaluating cost effectiveness).
- Probability of Success – The complexity of an action type may preclude its implementation.
- Partnership Capacity – Without partners, a project sponsor may lack the ability (e.g., quantity and quality of professionals) to design, implement, and adaptively manage the proposed actions.
- Regulatory Constraints – Regulatory issues such as permitting may make some actions more difficult to implement than others.
- Societal Issues – Some action types may be more difficult to implement because of societal issues such as conflicts with recreational activities or reintroduction of beavers into agricultural areas.

Those assessing feasibility may develop a scoring and weighting system that can be used to sequence restoration and protection actions within priority reaches. Total scores could be calculated by summing the product of each indicator score by its weight. These scores would then be sorted from highest to lowest, with the highest scores indicating highest priority. Because feasibility can change rapidly, a reevaluation of actions should occur at least annually.

Final Product

The result of the prioritization process will be a list of high priority actions to be implemented within high priority areas (priority reaches within priority assessment units) for each subbasin. Importantly, the prioritization process will not describe how specific actions are to be implemented. For example, within a specific reach, we may identify a levee as the cause of a disconnected floodplain that currently limits abundance or survival for a critical salmonid life stage. In this case, we will not state where or how the levee should be breached or removed. Rather, we will note that the levee needs to be addressed in order to restore off-channel connectivity and to improve habitat conditions for a critical life stage. Thus, project sponsors and their engineers will identify the best way to implement the priority action. The results of the prioritization process will be in GIS and housed on the Upper Columbia Salmon Recovery Board website.

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Attachment 1: Assessment Unit Prioritization Methods

Prepared by

Greer Maier
Upper Columbia Salmon Recovery Board

Robyn Pepin
Aspect Consulting, LLC.

Tracy Hillman
Upper Columbia Regional Technical Team

To develop the prioritization strategy for HUC 12 sub-watersheds ("Assessment Units"), the Upper Columbia Salmon Recovery Board (UCSRB) convened a sub-group of the Upper Columbia Regional Technical Team to develop a methodology and provide input and review on the products. The group compiled data that could be used to inform each of the indicators outlined in the overall strategy and developed scoring rules and weights for each indicator.

The list of indicators used to prioritize Assessment Units can be grouped into four categories: Assessment Unit Condition Indicators, Population Integrity Indicators, Habitat Integrity Indicators, and Future Security Indicators. Table 1 below shows each of the indicators and their definition, relevance, and data sources.

Table 1. Assessment unit prioritization indicators and their definitions and relevance.

Indicator	Definition	Relevance
Assessment Unit Condition Indicators		
Intrinsic potential	Amount (miles) of intrinsic potential currently within an assessment unit. For steelhead and Chinook this metric is weighted by the IP score (from 0.5-3), which corresponds to the modelled value (low-high). The metric is not weighted for bull trout because no rating is available.	Assessment units with a large amount of intrinsic potential will have an increased likelihood of persistence. Because the IP model is based on metrics associated with geomorphic potential this metric also captures the potential for habitat creation.
Spawning area designation	Major (MaSA) or minor (MiSA) spawning area designation or bull trout core population spawning area as identified in the appropriate recovery plan.	Major or minor spawning areas and bull trout core spawning areas constitute the strongholds for long-term persistence and viability and production within these areas is required for species delisting.
Population Integrity Indicators		
Life-Stage Use	Number of life stages that use an assessment unit (salmon and steelhead. Life stages include: adult migration, maturation/holding, spawning/incubation, summer rearing, winter rearing, and smolt emigration; bull trout: foraging/migration/overwintering, rearing, and spawning)	Supporting multiple life stages ensures that species can express their full life history and can exhibit multiple life-history strategies in a watershed. Life-history diversity manifests itself in use of different areas by different life stages

Indicator	Definition	Relevance
Spawner abundance	Number of spawning adults in an assessment unit on average across surveyed years.	Assessment units with a large number of spawners represent the strongholds from which a population can build. Assessment units with low densities of spawners are more vulnerable to extirpation.
Habitat Integrity Indicators		
Habitat quality	Characterization of habitat quality for each species based on the "4 C's"- Cold, Clean, Connected, and Complex as assessed through data on water quality, riparian condition, streamside road density, and the number of fish passage barriers.	Loss of habitat quality increases risk of extirpation and loss of life-history diversity.
Watershed function	Amount of AU that has been altered by land use activities based on a percent of area degraded.	Conversion of lands from natural habitats reduces habitat quality and availability.
Future Security Indicators		
Land stewardship	Area of federal or state lands with regulatory or congressionally-established habitat protections.	AUs with higher proportions of protected federal and state lands typically support higher quality habitat than do other lands.
Climate change	Areas sensitive to climate change will experience changes in hydrologic regimes (snow-dominated to transitional or transitional to rain-dominated), increased exposure to flood events, increased mean August temperatures, and reduced summer water availability.	Climate change is likely to threaten Chinook, steelhead, and bull trout because of warmer water temperatures, changes in peak flows, and increased frequency and intensity of disturbances such as floods and wildfires.
Non-native fish species (bull trout only)	Presence of brook trout in bull trout spawning areas.	Introduced brook trout can hybridize with native bull trout. Hybrids are usually sterile and hybridization reduces the genetic integrity of bull trout populations.

Weights for each indicator were developed based on the relative importance of each in assigning a priority to an individual assessment unit. Possible weights are presented in Table 2. Scoring rules for each indicator are presented in Table 3. Scoring rules for bull trout differ from those for steelhead and spring Chinook because of species-specific habitat criteria and different recovery plans. Although the indicators and data for restoration and protection were the same, the weighting and scoring rules for each indicator differed between prioritization of assessment units for protection versus priorities for restoration.

The tool was developed so that weightings, indicators, and scoring rules could easily be changed if needed. Individual scores for each species are calculated based on the sum of the individual scores, times their weighting factor. The total score across species was the sum of the three scores for each species (spring Chinook, steelhead, and bull trout). This allows users to evaluate the priority of assessment units for either protection or restoration on a species-by-species basis as well as across all three listed species. Total scores are ranked from highest to lowest, with the highest scores indicating the highest priority for either restoration or protection. In some cases, a score can have a value of “0,” which means that the assessment unit has no biological benefit for a particular species. For example, if there is no intrinsic potential for a given species, then the assessment unit receives a default score of “0” because there is no known potential for the species to use the assessment unit. Expert opinion can be used to override this rule if there is other evidence to support potential use.

Table 2. Assessment unit prioritization indicators weights (%) for both protection and restoration by species.

Indicator	Indicator weights (%)					
	Restoration			Protection		
	Spring Chinook	Steelhead	Bull trout	Spring Chinook	Steelhead	Bull trout
Intrinsic potential	15	15	12	5	5	5
Spawning areas	8	8	6	3	3	3
Life Stages	9	9	9	20	20	20
Spawner abundance	9	9	8	30	30	25
Habitat quality	35	35	30	18	18	15
Watershed function	10	10	8	5	5	5
Land stewardship	5	5	5	8	8	8
Climate change	9	9	12	11	11	14
Non-native fish species	0	0	10	0	0	5
Total	**100**	**100**	**100**	**100**	**100**	**100**

Each of the indicators is scored individually according to specific scoring rules (Table 3). Some indicators (e.g., habitat quality) are a composite score (Geomean) of sub-categories of data. Total scores for each species are calculated based on individual scores multiplied by the weighting factors and then summed.

The assessment unit prioritization results reflect certain assumptions about species and their habitat. Broadly speaking, this tool provides a suite of data that can be used to further refine the priority of each assessment unit based on its potential benefits to ESA-listed fish species. The tool does not provide the full suite of information that could be used to evaluate priorities but can be used alongside complementary information that informs priorities.

Table 3. Indicators, scoring rules, and data sources for protection and restoration.

Scoring Rules and Data Sources

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
Assessment Unit Condition Indicators			
Intrinsic Potential	Salmon and Steelhead: **Total length of IP (weighted)** 5 = >15 miles 4 = 10-15 miles 3 = 5-10 miles 2 = 1-5 miles 1 = 0.5-1 miles 0 = <0.5 miles Bull Trout: **Total length of IP (unweighted)** 5 = >15 miles 4 = 10-15 miles 3 = 5-10 miles 2 = 1-5 miles 1 = 0.5-1 miles 0 = <0.5 miles	Same as Protection	Intrinsic Potential Maps (NOAA, UCSRB)
Spawning Area Designation	**Spawning Area** 5 = HUC 12 with substantial level of spawning (>5 spawners avg) within MaSA 3 = HUC 12 with substantial level of spawning (>5 spawners avg) within MiSA 1 = HUC12 within MaSA or MiSA with little or no spawning (<5) but intrinsic potential (IP) 0 = HUC12 not part of a MaSA or MiSA or there is no potential for production in the HUC12 (little to no IP)	Same as Protection	Maps of salmon and steelhead MaSA and MiSA (NOAA), Spawning abundance data (see below), Life stage use (see below), IP data (see above)
Population Integrity Indicators			
Life-Stage Use	Salmon and Steelhead: **Number of Life Stages** 5 = All 6 life stages present	Same as Protection	Fish Monitoring Data (WDFW, ISEMP, Hatchery M&E, OBMEP), critical habitat layer

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	3 = 4 - 5 life stages present 1 = 2 - 3 life stage present 0 = 1 or 0 life stages present Bull Trout: **Number of Life Stages** 5 = All 3 life stages present 3 = 2 life stages present 1 = 1 life stage present 0 = no life stages present		(USFWS), fish distribution (USFS)
Spawners	**Number of Spawners** 5 = >=100 spawners 4 = 50-99 spawners 3 = 25-51 spawners 2 = 10-24 spawners 1 = 1-10 spawners 0 = 0 spawners	Same as Protection	Spawning Ground Surveys (Hatchery M&E, ISEMP, OBMEP) and PIT tag escapement data (WDFW)
Habitat Integrity Indicators			
Habitat Quality	**Water Quality (Mean August Temp and 303d listings):** 5 = No impairment to water quality (303d listing) and temperatures are suitable for spawning and rearing (<13 deg) 4 = No impairment to water quality (303d listing) and temperatures are optimal for rearing but not spawning (13-15 deg) 3 = No impairment to water quality (303d listing) but temperatures are suboptimal for rearing (15-20 deg) 2 = Water quality is poor (303d listing) but water temperature is <15 degrees 1 = Water quality is poor (303d listing) and temperatures are suboptimal for rearing (15-21 deg) 0 = Water is toxic to fish (>21 deg) **Temperature (NoRWeST 2002-2011 mean August temp)-thresholds based on this paper*	Same as protection except overall score is as follows: **Overall Score for AU Restoration:** Geomean (Water Quality, Connectivity, Temperature, Complexity) 5 = 1.5 – 2 4 = 2 – 2.5 3 = 2.5 – 3.6 2 = >3.6 1 = 1 – 1.5 0 = <1	Water quality (DOE & NorWeST), road density (USFS and NHD), connectivity (WDFW and NHD), riparian condition (NorWeST canopy metric)

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	Roads (sediment and complexity): 5 = Road density within 300' of the stream network <0.5 mi/sq mi 4 = Road density within 300' of the stream network 0.5-2 mi/sq mi 3 = Road density within 300' of the stream network 2-5 mi/sq mi 2 = Road density within 300' of the stream network 5-10 mi/sq mi 1 = Road density within 300' of the stream network >10 mi/sq mi **Connectivity:** **Flow** 5 = Flow is primarily perennial (>75% stream network) 3 = Flow is 25-75% perennial 1 = Flow is primarily intermittent (<25% perennial) **Barriers** 5 = There are no man-made passage impediments in the IP habitat in the Assessment Unit 4 = There are >0 - 1 man-made passage per IP km 3 = There are >1 - 3 man-made passage per IP km 2 = There are >3 - 5 man-made passage per IP km 1 = There are >5 man-made passage per IP km **Overall Score for Connectivity:** Mean (Flow and Barrier Density scores) **Riparian:** 5 = >80% of riparian zone is forested 4 = 61-80% of riparian zone is forested		

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	3 = 41-60% of riparian zone is forested 2 = 21-40% of riparian zone is forested 1 = 0-20% of riparian zone is forested **Overall Habitat Quality Score:** Geomean (Water Quality, Connectivity, Temperature, Complexity)		
Watershed Function	**Amount of land converted** 5 = 6 - 10% 4 = 0.1 - 5% 3 = 11-20% 2 = >20% 1 = 0%	**Amount of land converted** 5= 41-60% 4 = 20-40% 3 = 61-80% 2 = >80% 1 = <20%	Washington Dept. of Agriculture, USFS (roads), Google Earth (analysis by UCSRB)
Land stewardship	**Percent of land protected (%)** 5 = <30% of AU in protected status 3 = 30-90% protected 1 = >90% protected	**Percent of land protected (%)** 5 = >90% of AU in protected status 3 = 30-90% protected 1 = <30% protected	Washington Public Lands Inventory, Methow Conservancy, Chelan-Douglas Land Trust, WDFW, County land ownership map
Future Security Indicators			
Climate change	**Flow:** **Hydrologic Regime Shift (CFM)** 5 = Small hydrologic regime shift within the watershed (change in CFM<10 days±) 3 = Moderate hydrologic regime shift within the watershed (change in CFM 10-20 days±) 1 = Large hydrologic regime shift within the watershed (>20 days±) **Flood Events (Q1.5)** 5 = Small change in flood events (change Q1.5<10%) 3 = Moderate change in flood events (change Q1.5 [10-25%]) 1 = Large change in flood events (Q1.5>25%) **Summer Low Flow (MS)** 5= Small change in summer flow (change Q1.5<10%)	Same as protection	Washington Public Lands Inventory, Methow Conservancy, Chelan-Douglas Land Trust, WDFW

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	3 = Moderate change in flood events (change Q1.5 [10-25%]) 1 = Large change in flood events (>25%) **Overall Flow Score:** Geomean (Hydrologic Regime Shift, Flood Event, and Summer Low Flow) **Temperature:** **Temperature (MWMT)** 5 = 2040 MWMT are suitable for spawning and rearing (<10 deg) 3 = 2040 MWMT are optimal for rearing but not spawning (10-15 deg) 2 = 2040 MWMT are suboptimal for spawning and rearing (15-21 deg) 1 = 2040 MWMT >21 deg **Temperature (NoRWeST 2040 mean weekly max temp (MWMT)- thresholds based on* **Overall Climate Change Score:** Geomean (Flow and Temperature Scores)		
Non-native fish species (bull trout only)	Bull Trout: **Non-Native Species** 5 = Brook trout in bull trout spawning habitat within the AU 1 = No brook trout in bull trout spawning habitat	Same as Protection	Brook trout presence (Hatchery M&E, ISEMP, OBMEP, Angler/Creel Surveys) and bull trout spawner surveys (WDFW, USFWS)