HABITAT ACTION PRIORITIZATION WITHIN THE UPPER COLUMBIA RIVER BASIN

UCRTT
UPPER COLUMBIA REGIONAL TECHNICAL TEAM

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“People who can focus, get things done. People who can prioritize, get the right things done.”

John Maede

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Introduction

In this document, we describe a strategy for prioritizing protection[1] 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, life stages, 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*. The objective of the prioritization 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 decision making. 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 (BPA 2015), the Integrated Rehabilitation Assessment process, and other published studies (e.g., Roni et al. 2002; Williams et al. 2007; Beechie et al. 2008; Roni et al. 2013a, 2013b; Rieman et al. 2015; and Roni et al. 2018). Our approach is top-down[5] and 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 sub-basin 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 sub-basin. The next step (Step 2) consists of three

[1] Protection means any action or actions that maintain or "protects" existing high-quality (properly functioning) habitat from degradation. Possible actions include land acquisition, conservation easements, land swaps, 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. Attachment 2 identifies restoration categories and action types.

[5] "Top-down" means we begin the prioritization process at large spatial scales and work down through progressively smaller scales until specific action types are identified within priority reaches (Population → AU → Reach → Site).

pathways for identifying high-priority action types within priority AUs and reaches. The first pathway under Step 2 identifies reach-scale habitat impairments and selects action types to address those impairments. Here, the goal is to restore overall habitat conditions within priority AUs and reaches. The second pathway identifies limiting life stages at the population and assessment unit scale, identifies factors limiting those life stages, and identifies habitat action types to address those limiting factors. The final pathway identifies and prioritizes fish passage barriers within high-priority AUs.

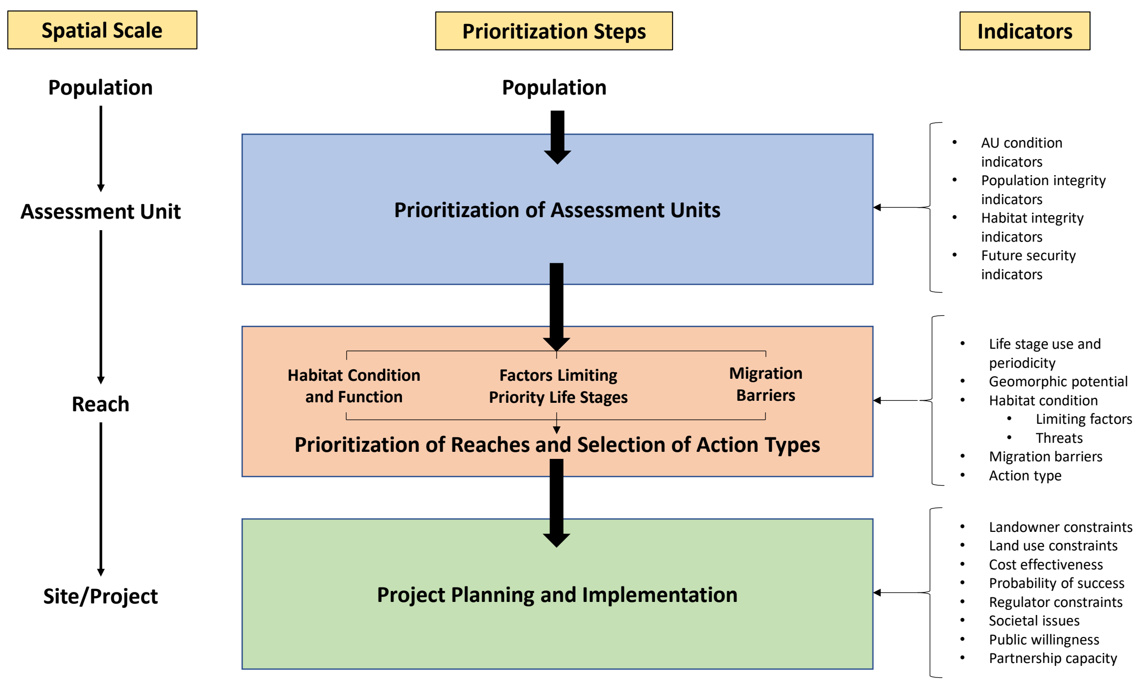

Figure 1. Three-step process for selecting habitat actions for restoration and protection.

For both Steps 1 and 2, we developed scoring rules for each element and created a spreadsheet/GIS 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, IT, and local project implementers, provided input and reviews throughout the development of Steps 1 and 2.

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[6]. Information will be contained on

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

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 greater 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 "sub-basins" (Crab, Wenatchee, Entiat, Chelan, Methow, and Okanogan sub-basins) and several smaller watersheds. This area captures the distribution of the Upper Columbia River Basin Summer Steelhead Distinct Population Segment (DSP) (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 Segment (listed in 1998). The Interior Columbia Basin Technical Recovery Team identified independent populations of summer steelhead and spring Chinook within the Upper Columbia (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 Upper Columbia DPS: Wenatchee, Entiat, Methow, Okanogan, and Crab Creek populations. Unlike with spring Chinook, summer steelhead populations include not only the major sub-basins but also 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.

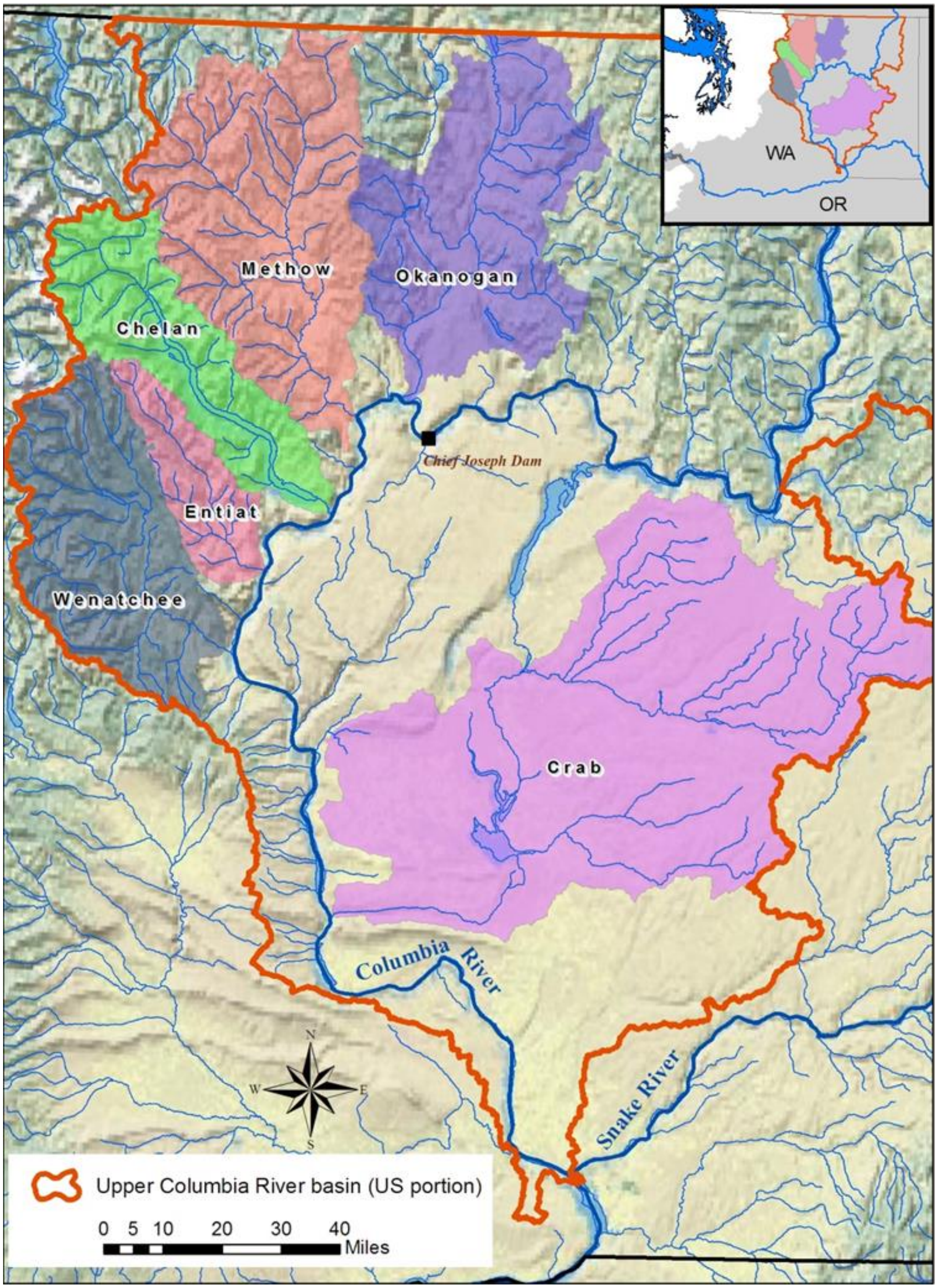

Figure 2. Major tributaries in the Upper Columbia River Basin.

For prioritization, we will focus on the Wenatchee, Entiat, Methow, and Okanogan sub-basins. 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 strategy does not rank populations or sub-basins 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.[7] Rather, this process prioritizes assessment units and reaches within each population or sub-basin. That is, the process will rank assessment units and reaches within the Wenatchee sub-basin independently of assessment units and reaches within the Methow sub-basin. Thus, each sub-basin 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 sub-basin (i.e., Wenatchee, Entiat, Methow, and Okanogan) for restoration and protection. Step 2 includes two or three pathways that result in high-priority restoration or protection actions at the reach scale. Restoration under Step 2 includes three pathways: one pathway focuses on improving overall habitat conditions within priority AUs, another focuses on implementing actions that address limiting life stages within priority AUs, and the last addresses fish migration barriers within priority AUs. Protection under Step 2 includes two pathways: one focuses on protecting high-quality areas to maintain overall habitat conditions within priority AUs, while the other focuses on protecting habitat important to limiting life stages within priority AUs. 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[8] 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 relatively 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 and Methow River sub-basins, 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

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

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

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., Wenatchee and Entiat sub-basins), 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 was to rank HUC 12 sub-watersheds ("assessment units") within each sub-basin for restoration and prioritization. This was 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 was 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 plans.
- 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.

We used these indicators 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 ranged from 1 to 5, with 5 being the preferred condition. The definition of each score depended on the species and whether we were prioritizing for restoration or protection. The scores were 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 were given greater weight than others. We assigned a different set of weights to indicators for different species and for restoration and protection.

The final step was to summarize the scores for each assessment unit, each species, and for protection and restoration. This was accomplished by summing the product of each indicator score by its weight. Total scores were then sorted from highest to lowest for each species and for protection and restoration. We then separated AUs into three tiers depending on their total scores. For spring Chinook and steelhead restoration, AUs with scores ≥80 were placed in Tier 1 (high-priority AUs), those with scores from 60-79 were placed in Tier 2 (moderate priority), and those <60 were placed in Tier 3 (low priority). For protection tiering for spring Chinook and steelhead, AUs with scores ≥75 were placed in Tier 1 (high priority), those with scores from 50-74 were placed in Tier 2 (moderate priority), and those with scores <50 were placed in Tier 3 (low priority). For bull trout protection and restoration, AUs with scores ≥70 were placed in Tier 1, those with scores from 60-69 were placed in Tier 2, and those <60 were placed in Tier 3. This is a simple and transparent way to rank assessment units for protection and restoration. The resulting tables of information and AU GIS maps (which can be found at Prioritization Portal) provides indicator data, individual indicator scores, indicator weights, and total scores by species. Every three to five years, the RTT will review and update information in Step 1.

The current EDT model in the Okanogan River basin accounts for most of the indicators identified in Step 1. Therefore, the EDT model was used to develop the tiers for restoration and protection in the Okanogan River basin based on assessment unit ranks provided by the model outputs.

Step 2: Reach and Habitat Action Type Prioritization

The second step of the prioritization process was to prioritize and rank habitat restoration and protection actions within high-priority assessment units and reaches. In order to do this, we first developed a reach network. Reaches were defined around geomorphically uniform channel segments with optimized lengths ranging from 1-4 km. The priority for setting reach break points was as follows:

1. Clear geomorphic discontinuities, such as a large change in gradient and/or valley confinement (e.g., the break between reaches Entiat 3a and Entiat 3b).
2. Length optimization (i.e., to split long, continuous reaches into practical management segments)
3. Integration of existing management reaches (e.g., previously defined reach break points).

Once reaches were defined for an entire sub-basin, we compiled a set of information for each reach including species presence, life stage use, and confinement (see Attachments 1 and 2 for more information on methods). Next, each reach went through a set of pathways to evaluate the habitat and determine the priority of the reach. Below we describe the pathways for restoration and protection. Results can be found at Prioritization Portal.

Restoration Prioritization

Step 2 included three pathways for prioritizing restoration actions. These pathways were based on the goals of restoring habitat function, addressing limiting factors, and addressing fish passage barriers. Each pathway had a series of hurdles (or filters) through which reaches were filtered to determine priority. After reaches went through each pathway independently, the results were combined into one list of priority reaches with associated information about why they were prioritized.

Restore Habitat Function Pathway

The purpose of the **Restore Habitat Function Pathway** is to identify impaired reaches where there is a need to restore overall ecosystem function. This pathway begins by filtering reaches based on geomorphic potential. Geomorphic potential reflects the ability of actions to affect habitat conditions based on valley confinement. This filter stems from the assumption that unconfined reaches offer more process-based enhancement opportunities than confined reaches. Thus, only unconfined, or partially unconfined reaches moved forward in this pathway (confinement <100%).

Unconfined reaches were then evaluated for the number of different life stages present. Life stages included adult migration, maturation and holding, spawning and incubation, fry rearing, summer rearing, winter rearing, and smolt emigration. Reaches were then evaluated for habitat quality. Reaches that contained more than three life stages for a given species were considered high-priority reaches for that species and moved forward in this pathway (see Attachment 2).

Habitat quality reflects the current condition of habitat within a reach and the potential for habitat improvement. Habitat condition was based on an important subset of habitat factors that reflected reach habitat function. These included:

- Water Temperature
- Flow
- Riparian Condition
- Substrate
- Large Wood
- Pools

- Off-Channel Habitat
- Bank and Channel Stability

Each reach received a score for each of these habitat factors (5 = Adequate, 3 = At Risk, and 1 = Unacceptable). In some cases, more than one metric contributed to the overall score for a habitat factor. For example, the score for riparian condition was an average of scores for riparian structure, riparian disturbance, and canopy cover.

Scores were largely taken from reach assessment Reach-Based Ecosystem Indicator (REI) values. In a large part, reach assessments used Properly Functioning Condition (PFC) criteria (NMFS 1996; USFWS 1998) to determine function. In cases where reach assessments were not available, we relied upon Level II Surveys (USFS 2016) or other available data (e.g., Integrated Status and Effectiveness Monitoring Program data and Columbia Habitat Monitoring Program data) to determine function of habitat metrics. In the Okanogan River basin, EDT model inputs and outputs were used to generate habitat attribute scores. In some cases, Level 1 raw data were used to generate scores as per the scoring criteria associated with Level II data. In other cases, "functional condition" scores for EDT Level 2 attributes were used. Data sources, ~~and~~ scoring criteria for metrics, and definitions of REI indicators are described in Attachment 2.

Individual scores were used to calculate an overall habitat-quality score for the reach. Individual habitat factor scores were added together, and that sum was divided by the highest score possible. When multiplied by 100, this provided an overall percent function for each reach. Reaches with habitat function <80% moved forward in this pathway and those with functional habitat (≥80%) were excluded as candidates for restoration. We assumed that reaches with good-excellent habitat (≥80%) provide little opportunity for improvement.

Based on geomorphic potential, life stages present, and habitat condition, we were able to identify high-priority reaches for restoration of habitat function across a suite of habitat factors. Restoring the ecosystem function of these reaches should improve habitat for multiple life stages in important assessment units.

The final step under this pathway was to identify appropriate restoration actions that if implemented would address the impaired habitat conditions within each priority reach. In order to do this, we first filtered out habitat factors that were already "adequate." Then, all remaining factors that were "at risk" or "unacceptable" became restoration targets in the reach. Action categories were linked with each target habitat factor (Attachment 2). The specific action categories are intended to provide a comprehensive list of potential activities that may be implemented to address target habitat factors and ecosystem function. They include both passive and active restoration approaches as well as management strategies that range from the site to watershed scale. Outputs of the habitat function pathway include prioritized reaches, impaired target habitat factors, and potential habitat actions to restore reach function.

Address Limiting Factors for Priority Life Stages Pathway

The purpose of the **Limiting Factor Pathway** is to alleviate potential limiting factors for priority life stages. This pathway relies on life stage priorities, life-stage-specific habitat requirements, habitat-quality data, geomorphic potential data, and life-stage habitat use and periodicity data.

The pathway begins by assessing and rating life stage importance within AUs. Watershed workgroups met several times in each sub-basin and evaluated the best available data by life stage. We assumed that restoring habitat conditions for high-priority life stages will improve the abundance and productivity of focal species (spring Chinook, steelhead, and bull trout). Life stages for steelhead and spring Chinook included adult migration, holding and maturation, spawning and incubation, fry rearing, summer rearing, winter rearing, and smolt emigration. Life stages for bull trout included adult migration, holding, spawning and incubation, natal rearing, subadult rearing, and adult non-spawning (see definitions in Attachment 2). Life stages were ranked based on restoration potential and the importance of the area to local (AU) and population survival and production.

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

Low Priority

- 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.

Medium Priority

- Life stage not present or at low abundance but restoration could provide additional capacity.
- Life stage is present but not limiting productivity to a large degree.
- Life stage is presumed to be important, but data are limited on how much it affects productivity.
- Life stage priority is intermediate between low and high priority.

High Priority

- Life stage is present (or should be present) and is known or presumed to be limiting productivity at the AU or population scale.

Once AUs were ranked, the next step was to develop a reach network for each life stage. For each life stage, a presence/absence determination for each reach was made based on observational data as well as modeled potential for a given life stage. The length of time a given life stage is present within a reach was not a factor. Methods for defining life stage use are given in Attachment 2. For high-priority life stages in Tier 1 AUs, this reach network was used for the next step in the limiting factor pathway.

For each high-priority life stage within a Tier 1 AU, limiting factors were evaluated using a similar approach described under the Habitat Function Pathway. This included rating as high priority reaches with more than three life stages for a given species and advanced in this pathway (see Attachment 2). Under this pathway, however, we focused on life-stage-specific habitat impairments to identify potential limiting factors by life stage at the reach scale. For example, if spawning and incubation was identified as a priority life stage for a given species and AU, then habitat condition at the reach scale was evaluated based on the specific habitat requirements for that life stage. In this case (spawning and incubation), we focused on temperature, stream flow, and substrate, because these factors directly affect the survival and capacity for this life stage. On the other hand, if adult holding and maturation was the priority life stage, habitat conditions based on cover, stream flow, temperature, pool quality and quantity, predation, and harassment were evaluated. Data sources for all habitat factors in the limiting factor pathway are described in Attachment 2. High-priority reaches with habitat requirements rated as "unacceptable" or "at risk" were considered potential limiting factor priorities and assigned an action category.

We used geomorphic potential as the final filter in this pathway. However, in this pathway, this filter was only used to remove off-channel-action categories in reaches that were 100% confined because of the lack of potential for implementing actions in these reaches. The same rules for scoring geomorphic potential used under the Restore Habitat Function Pathway applied here (see Attachment 2).

The final step under this pathway was to identify appropriate habitat action types that if implemented would address the impaired life-stage-specific habitat conditions within each priority reach. As before, we identified action types that link with each impaired habitat condition. The specific action types are intended to provide a comprehensive list of potential activities that might be implemented to address impaired life-stage-specific habitat conditions. Results from the limiting factor pathway include priority reaches with potential limiting factors for high-priority life stages and habitat action types to address these limiting factors. In some cases, habitat impairments and actions identified under this pathway are the same as those identified in the Habitat Function Pathway in which case the reach is noted as a priority under both pathways with associated information about reach function and limiting factors for specific life stages.

Restore Connectivity Pathway

The purpose of the **Restore Connectivity Pathway** is to restore fish passage in blocked streams. This pathway addresses impairments associated with dams, diversions, culverts, bridges, and other unnatural and natural fish passage impediments. This pathway relies on results from various fish passage assessments in the region and subsequent use of the Upper Columbia Fish Passage Prioritization Tool (UCRTT 2019; see results here). This tool prioritized passage barriers based on species indicators (e.g., core population designations, colonization potential, and species use), habitat indicators (e.g., habitat quality, habitat quantity, and future habitat quality), and barrier indicators (e.g., barrier severity and presence of downstream barriers). The tool scored each indicator, which were assigned weights based on their assumed importance in prioritizing barriers, and then calculated a total score for each barrier. Total scores were ranked from highest to lowest, with the highest scores indicating the barriers that would provide the greatest biological benefit if fixed. We then ranked projects based on their total scores. We created four categories with "High Priority" including barriers with the highest biological benefit, "Moderate Priority" including barriers of moderate biological benefit, "Low Priority" including barriers of low biological benefit, and the last category is for barriers that are "Not a Priority at this Time." Additional categories included "Need More Information" and "Proceed Only as a Complex." A barrier prioritization has not been completed for the Okanogan River basin and therefore the EDT model information on the effect of obstructions was used to generate a list of high and moderate priority barriers.

In this pathway, all "High-Priority" barriers for a species are considered high-priority actions to implement regardless of where they occur in the watershed. Thus, if a high-priority barrier exists within a low-priority AU (Tier 3 AU), addressing that barrier is considered a high priority. "Moderate-Priority" barriers, on the other hand, are considered high-priority actions only if they occur within high-priority AUs. "Moderate-Priority" barriers that exist within Tier 2 or 3 AUs are not considered high-priority projects at this time. All reaches identified as a priority through this pathway were assigned an action category of "Address Fish Passage Barriers."

Combining Pathways and Ranking Reaches for Restoration

Once priority reaches were identified through the three pathways, redundancies were addressed and reaches were placed into one of three categories within each priority AU: Rank 1 (highest priority), Rank 2 (medium priority), and Rank 3 (lowest priority). Reaches were not ranked among AUs due to the importance of restoring reaches within all high-priority AUs. Ranking of reaches was intended to help project sponsors and funders understand the greatest needs within the AU. Below we describe the rules for ranking reaches for restoration.

1. Any reach containing a high- or moderate-priority fish passage barrier was identified automatically as a Rank 1 reach.
2. Any reach that dewaters due to human activity at some point during the year was identified as a Rank 1 reach.
3. All remaining reaches were evaluated based on the following habitat indicators:
    a. Confinement:
        0-100% Unconfined (highest rank for most unconfined reaches)
    b. Habitat Quality:
        0-100% Habitat Degradation (highest rank for most degradation)
    c. Limiting Factors for High-Priority Life Stages:
        0-100% of habitat attributes that are limiting (highest rank for most attributes limiting; score of 0 if there are no high-priority Life Stages)

Percent values related to each of these three attributes were used to rank reaches. Raw percentages were used to generate scores for confinement. Habitat-quality scores were used to evaluate habitat degradation (100% - [habitat quality %] = [habitat degradation %]). Limiting factor scores were generated based on the number of "unacceptable" habitat factors within the reach as a percent of the total habitat requirements. Overall reach scores were calculated as the sum of individual scores (total score range of 0-300%). These total scores were sorted from highest to lowest within each AU and assigned a rank based on the binning of percentages into terciles (Rank 1 = lowest tercile, Rank 2 = middle tercile, and Rank 3 = lowest tercile). In the Okanogan River basin, the EDT model provided the relative rankings.

Protection Prioritization

Step 2 included two pathways for prioritizing protection actions. These pathways are based on the goals of protecting habitat function and protecting intact habitat for priority life stages. The pathways for protection are similar to those described above for restoration but with modified filters.

Protect Habitat Function Pathway

The purpose of the **Protect Habitat Function Pathway** is to protect reaches with highly functional habitat. This pathway relies on the same data used for restoration prioritization – confinement, habitat quality, and life-stage habitat use by reach. Prioritization for each species focused on: (1) reaches in Tier 1 watersheds with high-quality, connected habitat; (2) unconfined reaches (confinement <100%); and (3) reaches supporting more than three life stages. Individual habitat factor scores were used to calculate an overall habitat-quality score for each reach. Reaches with habitat function ≥70% moved forward in this pathway and those without functional habitat were removed. We assumed that reaches with good-excellent habitat provide the most intact habitat function and therefore the greatest need for protection.

The final step under this pathway was to identify appropriate protection actions for priority reaches. Priority protection reaches that had some amount of land that was publicly owned or under some current level of protection status were assigned an action category of "Land Management for Protection."[9] Reaches that had at least some land that was not under any current level of protection (e.g., privately owned and not under easement) were assigned an action category of "Land Protection (e.g., conservation easement and/or property acquisition)." Reaches that had both protected and unprotected lands were assigned both action categories for protection.

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[9] "Land Management" includes floodplain and riparian habitat that are under public ownership and may be managed for various activities (e.g., limited grazing, mineral extraction, recreation, etc.). Some of these activities may not adequately protect the lands for fish conservation.

Protect Habitat for Important Life Stages Pathway

The purpose of the **Protect Habitat for Important Life Stages Pathway** is to protect reaches that provide important habitat for high-priority life stages. Much like the protect habitat function pathway, this pathway focused on: (1) reaches in Tier 1 watersheds with high-quality, connected habitat; (2) unconfined reaches (confinement <100%); and (3) reaches supporting more than three life stages. An additional criterion was added for habitat quality at the reach scale (habitat quality >50%) to ensure that priority was placed on reaches with overall habitat function. In this pathway, the approach also looked at life-stage use by reach and life-stage habitat requirements. The habitat function of each reach was evaluated for each life stage using a similar methodology as was used for habitat quality in the habitat function pathway (a sum of scores divided by the total possible scores). In this case, the habitat function was based only on those habitat factors that were identified as critical to sustain that life stage (we called these "core metrics"). The list of core metrics used to evaluate habitat function by life stage are provided in Attachment 2. Any reach that scored >70% habitat function for a high-priority life stage moved forward as a priority reach for protection. This ensured that reaches that were helping to support and maintain important life stages within the AU were prioritized for protection. As described above, reaches that were identified as a priority for protection through this pathway were assigned an action category based on land ownership and management.

Combining Pathways and Ranking Reaches for Protection

Similar to restoration, once priority reaches were identified through the two pathways and redundancies were addressed, reaches were placed into one of three categories within each priority AU: Rank 1 (highest priority), Rank 2 (medium priority), and Rank 3 (lowest priority). Below we describe the rules for ranking reaches for protection.

1. Any reach that has a Habitat Quality score of less than 50% was not given a protection rank.
2. Any reach that is already ≥90% protected was identified automatically as a Rank 3 reach.
3. All remaining reaches were evaluated based on the following habitat indicators:
    a. Confinement:
        0-100% Unconfined (highest ranks for most unconfined reaches)
    b. Habitat Quality:
        0-100% Habitat Quality (highest ranks for highest quality)
    c. Habitat Quality for High-Priority Life Stages:
        0-100% of habitat attributes are "acceptable" (highest ranks for most attributes acceptable; score of 0 if there are no high-priority life stages)
    d. Threats (based on percent floodplain disturbance):
        0-100% disturbed (highest rank for most disturbed floodplain)[10]

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[10] We assume a reach with evidence of floodplain disturbance is most likely to be further impaired over time.

e. Connection to other existing protected areas:

0-90% protected (highest ranks for most existing contiguous protection)[11]

Criteria for ranking reaches that were prioritized for protection were aimed at elevating those reaches that had the greatest potential value to listed species, had the greatest potential threat (as indicated by existing disturbance in the reach), and had the most surrounding protected habitat (in order to avoid small "islands" of protection within a reach). Percent values associated with each of the five attributes were be used to score and rank reaches. Overall reach scores were calculated as the sum of individual scores (total score range of 0-500%). These total scores were sorted from highest to lowest within each AU and assigned a rank based on the binning of percentages into terciles (Rank 1 = lowest tercile, Rank 2 = middle tercile, and Rank 3 = lowest tercile). In the Okanogan, the EDT model provided the relative rankings.

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. A possible list of indicators that could be used to assess feasibility include:

- 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.

[11] The goal is to have large contiguous reaches of protected, high-quality habitat rather than several small, disconnected, protected parcels of high-quality habitat.

- 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 and floodplain management 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 is a map of species-specific, high-priority reaches, habitat factors/limiting factors, limiting life stages, and actions within high-priority areas of each sub-basin. The Upper Columbia Prioritization Web Map - Prioritization Portal includes maps showing the results of Steps 1 and 2 including HUC 12 (AU) priorities for restoration and protection, life stage priorities by species, priority reaches, reach habitat ratings for all habitat factors, and identified actions (barriers and reach assessment opportunities). Information associated with priority ratings is also provided in the Web Map as is a list of priority limiting factors, life stages, and action categories for each priority reach.

Importantly, the prioritization process and resulting Web Map and documentation do not describe how specific actions are to be implemented. For example, within a specific reach, we may identify floodplain habitat connectivity as a priority limiting factor and may list potential action categories to address floodplain disconnection. The list, however, will not identify the reason for the disconnected floodplain (e.g., levee) that currently limits abundance or survival for a critical salmonid life stage. Furthermore, if a levee is the reason for the disconnected floodplain, we do not state where or how the levee should be breached, removed, or setback. Project sponsors and their engineers will need to refer to existing documentation of project opportunities and then identify the most appropriate way to address a limiting factor. The results of the prioritization process are in GIS and housed on the Upper Columbia Salmon Recovery Board website.

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Attachment 1: Methods for Step 1 - Prioritizing Assessment Units

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 1.1. 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
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

Indicator	Definition	Relevance
		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 1.2. 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 1.3. Indicators, scoring rules, and data sources for protection and restoration.

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 3 = 4 - 5 life stages present 1 = 2 - 3 life stage present	Same as Protection	Fish Monitoring Data (WDFW, ISEMP, Hatchery M&E, OBMEP), critical habitat layer (USFWS), fish distribution (USFS)

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	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		
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* **Roads (sediment and complexity):**	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
	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:** <u>Mean (Flow and Barrier Density scores)</u> **Riparian:** 5 = >80% of riparian zone is forested 4 = 61-80% of riparian zone is forested 3 = 41-60% of riparian zone is forested 2 = 21-40% of riparian zone is forested		

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	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%) 3 = Moderate change in flood events (change Q1.5 [10-25%])	Same as protection	Washington Public Lands Inventory, Methow Conservancy, Chelan-Douglas Land Trust, WDFW

Indicator	Protection Scoring Rules	Restoration Scoring Rules	Data Source
	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)

Attachment 2: Data and Scoring Rules for Step 2 - Prioritizing Reaches

In this attachment, we identify the information and scoring rules used to complete Step 2 of the prioritization process. The goal here is to identify action categories that address high-priority factors and life stages within high-priority reaches in high-priority assessment units. In short, the information contained in this attachment is used to make sure the right action is implemented within the right spot at the right time.

Linkage between Habitat Attribute and Habitat Action Category

Table 2.1. List of habitat attributes and habitat action categories.

Habitat Attribute	Action Category
Percent Fines/Embeddedness	Bank Restoration
	Channel Complexity Restoration
	Channel Modification
	Fine Sediment Management
	Upland Management
Bank Stability	Bank Restoration
	Channel Complexity Restoration
	Channel Modification
	Floodplain Reconnection
	Side Channel/Off-Channel Habitat Restoration
Brook Trout	Brook Trout Management
Channel Stability	Bank Restoration
	Channel Complexity Restoration
	Channel Modification
	Floodplain Reconnection
	Side Channel/Off-Channel Habitat Restoration
Coarse Substrate	Channel Complexity Restoration
	Channel Modification
	Fine Sediment Management
	Upland Management
Contaminants	Water Quality Improvement
Cover- Boulders	Channel Complexity Restoration
Cover- Undercut Banks	Bank Restoration
	Channel Modification
	Riparian Restoration and Management
Cover- Wood	Channel Complexity Restoration
	Channel Modification
	Riparian Restoration and Management
Entrainment/Stranding	Entrainment/Stranding Mitigation
Flow- Scour	Channel Modification
	Floodplain Reconnection
	Upland Management
Flow- Summer Base Flow	Channel Modification
	Instream Flow Acquisition, Protection, Restoration
	Upland Management

Habitat Attribute	Action Category
Food- Food Web Resources	Enhance Food Resources
Harassment	Harassment Management
Icing	Bank Restoration
	Channel Modification
	Floodplain Reconnection
Floodplain Connectivity	Floodplain Reconnection
Side-Channel/Off-Channel	Side Channel/Off-Channel Habitat Restoration
Pool Quantity & Quality	Channel Complexity Restoration
	Channel Modification
	Fine Sediment Management
	Channel Complexity Restoration
	Channel Modification
	Fine Sediment Management
Predators- Adult	Channel Complexity Restoration
	Predator Management
	Side Channel/Off-Channel Habitat Restoration
Predators- Juveniles	Channel Complexity Restoration
	Floodplain Reconnection
	Predator Management
	Side Channel/Off-Channel Habitat Restoration
Riparian	Bank Restoration
	Floodplain Reconnection
	Instream Flow Acquisition, Protection, Restoration
	Riparian Restoration and Management
	Side Channel/Off-Channel Habitat Restoration
Stability	Bank Restoration
	Channel Complexity Restoration
	Channel Modification
	Floodplain Reconnection
	Side Channel/Off-Channel Habitat Restoration
Superimposition	Superimposition Management
Temperature (by life stage)	Water Quality Improvement

Life Stage Definitions

Life stages for spring Chinook and steelhead include Adult Migration, Maturation/Holding, Spawning/Incubation, Fry Rearing, 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). Reach network determined as reaches below spawning reaches.
- **Holding and Maturation** – adults spending an extended period of time (days to weeks to months) in an area (requires adequate flow and temperature during holding period). Reach network determined as reaches downstream of spawning where fish could hold for extended periods of time (spring Chinook).
- **Spawning and Incubation** – spawning occurs in the AU (this life stage includes eggs, embryos, and alevins). Reaches network defined as those with observations of redds or reaches that have modeled spawning potential (using Quantile Regression Forest model- See et al. 2021).
- **Fry** – fry rearing occurs within the reach (requires low velocities and cover). Reach network defined as all reaches with spawning or spawning potential as well as immediate reaches downstream.
- **Summer Rearing** – parr rearing during low flows and higher temperatures (defined as June through October). Reach network defined as reaches with intrinsic potential (IP).
- **Winter Rearing** – parr rearing during low temperatures (<10°C) and often low flows (defined as November through May). Reach network defined as reaches with intrinsic potential (IP).
- **Smolt Emigration** - smolts are moving downstream through an AU to the ocean (only AUs downstream of areas that have winter habitat upstream have smolt emigration). Reach network defined as those reaches used for outmigration.

Linkage between Habitat Action Category and Salmonid Life Stage

Table 2.2. Habitat requirement by spring Chinook and steelhead life stage. Core metrics for each life stage are indicated by "*" (see section Protect Habitat for Important Life Stages Pathway for description of core metrics).

Spring Chinook and Steelhead	
Life Stage	**Habitat Attribute**
Adult Migration	Flow- Summer Base Flow*
Holding and Maturation	Cover- Boulders
	Cover- Undercut Banks
	Cover- Wood*
	Flow- Summer Base Flow*
	Harassment
	Pool Quantity & Quality*
	Pools- Deep Pools
	Predators- Adult
	Temperature- Adult Holding*
Fry	Coarse Substrate*
	Cover- Wood*
	Entrainment- Fry*
	Floodplain Connectivity*
	Off-Channel- Side-Channels*
	Predators Fry (steelhead only)
Spawning and Incubation	Percent Fines/Embeddedness*
	Coarse Substrate*
	Contaminants
	Flow- Scour*
	Flow- Summer Base Flow
	Harassment
	Hybridization (spring Chinook only)
	Icing
	Off-Channel- Side-Channels (spring Chinook only)
	Superimposition (spring Chinook only)
	Temperature- Adult Spawning (spring Chinook only)*
Summer Rearing	Coarse Substrate*
	Contaminants
	Cover- Boulders
	Cover- Undercut Banks
	Cover- Wood*
	Entrainment- Summer Rearing

	Flow- Summer Base Flow*
	Food- Food Web Resources
	Floodplain Connectivity*
	Off-Channel- Side-Channels*
	Pool Quantity & Quality*
	Predators- Juveniles
	Temperature- Rearing*
Winter Rearing	Percent Fines/Embeddedness*
	Coarse Substrate*
	Cover- Boulders
	Cover- Wood*
	Flow- Scour
	Icing
	Floodplain Connectivity*
	Off-Channel- Side-Channels*
Smolt Outmigration	Predators- Juveniles*

Table 2.3. Habitat requirement by bull trout life stage. Core metrics for each life stage are indicated by "*" (see section Protect Habitat for Important Life Stages Pathway for description of core metrics).

Bull Trout	
Life Stage	**Habitat Attribute**
Adult Migration	Flow- Summer Base Flow*
Holding and Maturation	Cover- Boulders
	Cover- Undercut Banks
	Cover- Wood*
	Flow- Summer Base Flow*
	Harassment
	Pool Quantity & Quality*
	Pools- Deep Pools
	Predators- Adult
	Temperature- Adult Holding*
Spawning and Incubation	% Fines/Embeddedness*
	Brook Trout*
	Coarse Substrate*
	Contaminants
	Flow- Scour*
	Harassment
	Icing
Natal Rearing	Brook Trout*
	Coarse Substrate*
	Cover- Undercut Banks
	Cover- Wood*
	Floodplain Connectivity*
	Off-Channel- Side-Channels
	Temperature- BT Rearing*
Subadult Rearing	Brook Trout*
	Coarse Substrate*
	Contaminants
	Cover- Undercut banks
	Cover- Wood*
	Flow- Summer Base Flow*
	Food- Food Web Resources
	Floodplain Connectivity*
	Off-Channel- Side-Channels
	Pool Quantity & Quality*
	Predators- Juveniles
	Temperature- BT Rearing*
FMO (Adult Non-Spawning)	Contaminants
	Flow- Summer Base Flow*
	Food- Food Web Resources
	Harassment
	Pool Quantity & Quality*
	Temperature- FMO*

Data Sources Table

Table 2.4. Habitat attributes, metrics, and data sources used for protection and restoration prioritization analysis. This includes Reach-based Ecosystem Indicator (REI) ratings from Reach Assessments. The prioritization pathway was indicated as LF for Limiting Factor pathway and HQ for Habitat Quality pathway. Habitat attributes that defaulted to REI metrics, when present, are indicated as such (indicated with "*"). REI ratings are described in Tables 2.6 and 2.7.

Habitat Attribute	Metric	Data Source(s)
Substrate		
Cover – Boulder	percent boulder cover	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only)
Coarse Substrate	REI substrate rating*, percent gravel and cobble	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ), Okanogan: EDT_UCSRBCoarseSub pct
Fines	REI substrate rating, percent fines, D50	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only), Okanogan: EDT_Level 2 Fine Sediment
Embeddedness	REI substrate rating, percent embedded, D50	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only), Okanogan: EDT_Level 2 Embeddedness
Large Woody Material		
Cover- Wood	REI large woody material rating*, pieces per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ), Okanogan: EDT_Woody Debris
Pools		
Deep Pools	deep pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ)
Pool Quantity and Quality	REI pools rating*, percent habitat as pools, pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), Okanogan: EDT_Scour Pool pct
Off-channel and Floodplain		
Off-Channel/Side-Channel	REI off channel habitat refugia ratings*, percent habitat as side channels	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), ocular estimation from satellite data (LF and HQ), UCSRB analysis (see notes in data set)
Floodplain	REI floodplain connectivity rating*, confinement/ entrenchment ratio	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), ocular estimation from satellite data (LF and HQ), Okanogan: EDT_Floodplain pct, UCSRB analysis (see notes in data set)
Undercut Banks	REI bank stability/channel migration rating, REI riparian structure rating, percent shoreline as undercut banks	Reach Assessments (LF only), CHAMP (LF only)
Bank Stability	REI bank stability/channel migration rating*	Reach Assessments (HQ only), ocular estimation from satellite data (HQ only), Okanogan: EDT_Level 2 Confinement: Artificial, UCSRB analysis (see notes in data set)

Habitat Attribute	Metric	Data Source(s)
Channel Stability	REI vertical channel stability*	Reach Assessments (HQ only), ocular estimation from satellite data (HQ only), Okanogan: EDT_Level 2 Confinement: Artificial, UCSRB analysis (see notes in data set)
Riparian		
Riparian Cover	REI riparian canopy cover rating, percent riparian canopy cover	Reach Assessments (HQ only), Level II surveys (HQ only), LiDAR (HQ only)
Riparian Disturbance	REI riparian disturbance rating*, percent riparian disturbance	Reach Assessments (HQ only), LiDAR (HQ only)
Streamflow		
Streamflow – Summer Baseflow	Reach Assessment watershedREI watershed-scale streamflow streamflow ratingrating, Clean Water Act 305(b) "4c" listing, streamflow permanence probability, Atlas flow condition	Reach Assessments (HQ and LF), Clean Water Act 305(b) listing (HQ and LF), USGS Probability of Streamflow Permanence (PROSPER) (HQ and LF), WDFW Atlas project (HQ and LF), Okanogan: EDT_Width, EDT_Level 2 Flow: Inter-Annual Low Flow Variation, WDFW Atlas, PROSPER
Temperature		
Summer water temperature	average august water temperature, Clean Water act 305(b) listings, Reach Assessment watershedREI watershed-scale temperature rating	NorWeST Summer temperature data (HQ and LF), Clean Water Act 305(b) listing (HQ and LF), Reach Assessments (HQ and LF)
Contaminants		
Contaminants	Clean Water Act 303(d) listings	303(d) Clean Water Act 303(d) listings (LF only)

*Habitat Attribute defaults to REI metric when present.

Rating Criteria Table

Table 2.5. Indicators, rating criteria, and data sources for protection and restoration. Habitat Quality Rating Criteria include three numbers: 1, 3, and 5, which translate to Unacceptable (1), At Risk (3), and Adequate (5), corresponding with the REI rankings. Note REI ratings are not included in the protection and restoration rating criteria because the REI ratings are directly reflected (i.e., REI rating of Unacceptable = 1, REI rating of At Risk = 3, REI rating of Adequate = 5). The Habitat Quality Rating Criteria were used for both restoration and protection, as well as for Spring Chinook, Steelhead, and Bull Trout prioritization, unless otherwise indicated.

Habitat Attribute	Metric	Habitat Quality Rating Criteria	Data Source(s)
Substrate			
Cover – Boulder	percent boulder cover	Percent Boulder Cover 1: 0% 3: 0% < and < 5% 5: >= 5%	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only)
Coarse Substrate	percent gravel and cobble	1: 0% 3: 0% < and < 50% 5: >= 50%	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ), Okanogan: EDT_UCSRBCoarseSub pct
Fines	percent fines	1: > 20 % fines 3: 12 – 20% fines 5: < 12% fines	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only)
Fines/Embeddedness	D50	1: <10 mm D50 3: 10-20 mm D50 5: >20 mm D50	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only)
Embeddedness	percent embedded	1: >30% embedded 3: 15-30% embedded 5: <15% embedded	Reach Assessments (LF only), Level II surveys (LF only), CHAMP (LF only)
Large Woody Material			
streams <5m wetted width			
Cover- Wood	pieces per mile	1: 0 pieces of wood/mi 3: > 0 and < 20 pieces of wood/mi 5: >20 pieces of wood/mi	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
streams >5m wetted width			
Cover- Wood	pieces per mile	1: < 17 pieces of wood/mi 3: 17- 70 pieces of wood/mi 5: >70 pieces of wood/mi	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
Pools			
all widths			
Deep Pools	percent deep pools	1: no pools are >3ft 3: 1-20% of pools are >3ft 5: >20% of pools are >3ft	Reach Assessments (LF and HQ), Level II surveys (LF and HQ)
Deep Pools	deep pools per mile	1: no pools are >3ft 3: 0.1-5 deep pools per mile 5: >5 deep pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ)

Habitat Attribute	Metric	Habitat Quality Rating Criteria	Data Source(s)
Pools – Channel Unit	percent habitat as pools	1: <10% pool channel area 3: 10-20% pool channel area 5: >20% pool channel area	Reach Assessments (LF only), Level II surveys (LF only), Okanogan: EDT_Scour Pool pct
0 – 5 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <184 pools per mile 5: ≥184 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
5 – 10 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <95 pools per mile 5: ≥95 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
10 – 15 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <70 pools per mile 5: ≥70 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
15 – 20 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <55 pools per mile 5: ≥55 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
20 – 25 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <47 pools per mile 5: ≥47 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
25 – 50 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <25 pools per mile 5: ≥25 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
50 – 75 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <23 pools per mile 5: ≥23 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
> 75 feet stream wetted width			
Pool Quantity and Quality	pools per mile	1: <18 pools per mile 5: ≥18 pools per mile	Reach Assessments (LF and HQ), Level II surveys (LF and HQ), CHAMP (LF and HQ)
Off-channel and Floodplain			
Side Channels	percent habitat as side channels	1: <2% side channel area 3: 2-5% side channel area 5: >5% side channel area	Reach Assessments (LF and HQ), Level II surveys (LF and HQ)
Floodplain	confinement/ entrenchment ratio	1: <1.4 ratio 3: 1.41-2.2 ratio 5: >2.2 ratio	Reach Assessments (LF and HQ), Level II surveys (LF and HQ)
Floodplain	EDT floodplain (channel wetted edge that is diked or ditched)	(Okanogan Steelhead Only) 1: >50% wetted edge diked/ditched 3: 1-50% wetted edge diked/ditched 5: 0% wetted edge diked/ditched	EDT_Floodplain pct
Undercut Banks	percent shoreline as undercut banks	1: <2% undercut bank area 3: 2-5% undercut bank area 5: >5% undercut bank area	Reach Assessments (LF only), CHAMP (LF only)

Habitat Attribute	Metric	Habitat Quality Rating Criteria	Data Source(s)
Riparian			
Riparian Cover	percent riparian canopy cover	1: 0-50% canopy cover 3: 50-80% canopy cover 5: >80% canopy cover	Reach Assessments (HQ only), Level II surveys (HQ only), LiDAR (HQ only)
Streamflow			
Streamflow – Summer Baseflow	Clean Water Act 305(b) "4c" listing	1: listed as 4c 5: listed as 1	Clean Water Act 305(b) listing (HQ and LF)
Streamflow – Summer Baseflow	PROSPER streamflow permanence probability	1: < 1 3: 1 <= and <= 3 5: > 3	USGS Probability of Streamflow Permanence (PROSPER) streamflow permanence probabilities (HQ and LF)
Temperature			
Temperature-Holding	average august water temperature	1: >14°F 3: 12 - 14°F 5: < 12°F	NorWeST Summer temperature data (HQ and LF)
Temperature-Spawning and Incubation	average August water temperature	1: >14°F 3: 10 - 14°F 5: < 10°F	NorWeST Summer temperature data (HQ and LF)
Temperature-Rearing	average August water temperature	1: >22°F 3: 16 - 22°F 5: < 16°F	NorWeST Summer temperature data (HQ and LF)
Temperature-FMO	average August water temperature	(Bull Trout only): 1: >22°F 3: 16 - 22°F 5: < 16°F	NorWeST Summer temperature data (HQ and LF)
Summer water temperature	Clean Water act 305(b) listings	1: 4A, 4B, 4C, 5 3: 2 5: 1	305(b) listing (HQ and LF)
Contaminants			
Contaminants	Clean Water Act 303(d) listings	1: listed 3: listed but not limiting 5: not listed	303(d) Clean Water Act 303(d) listings (LF only) [excluding listings for pH, dissolved oxygen, and bacteria.]

Reach-Based Ecosystem Indicators

Reach-Based Ecosystem Indicators (REI) definitions for "Adequate," "At Risk," and "Unacceptable" ratings. These ratings are based on National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife (USFWS) matrix of pathways and indicators (NMFS 1996; USFWS 1998), and from more recent adaptions to those pathways and indicators by the United States Bureau of Reclamation (USBR 2012). These definitions may vary based on application; however, most reach assessments use similar definitions to those in this table. The pathway, general indicator, and specific indicator are given for each metric. REI metrics include watershed-scale (Table 2.6) and reach-scale (Table 2.7) metrics.

Table 2.6. Watershed-scale metrics.

Adequate	At Risk	Unacceptable
Pathway: Watershed Condition		
General Indicator: Drainage Network and Hydrologically Impaired Surfaces		
Specific Indicator: Increase in Drainage Network/ Hydrologically Impaired Surfaces		
Zero or minimal increases in the drainage network that is correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total < 8%. Road density <1 mile/miles^2.	Low to moderate increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total between 8 and 14.9%. Road density 1-2.4 miles/miles^2.	Substantial increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total > 15%. Road density >2.4 miles/miles^2.
General Indicator: Disturbance Regime		
Specific Indicator: Natural/Human Caused		
Environmental disturbance is short-lived; predictable hydrograph, high-quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Localized events of hillslope contributions, avulsion, lateral migrations, minor bed incision, or wildfires. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, hillslope contributions, avulsion, lateral migrations, minor to major bed incision (head cuts), or wildfires throughout a majority of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.
Pathway: Flow/Hydrology		
General Indicator: Streamflow		
Specific Indicator: Alterations to Peak/Base Flows		
Magnitude, timing, duration, and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.
Pathway: Water Quality		
General Indicator: Temperature		

Adequate	At Risk	Unacceptable
Specific Indicator: 7-day average maximum temperatures		
Spring Chinook and Steelhead: spawning: <13°C rearing: <15°C holding & migration: <15°C **Bull Trout:** incubation: 2 - 5°C rearing: 4 - 12°C spawning: 4 - 9°C And temperatures do not exceed 15°C in areas used by adults during migration (no thermal barriers)	**Spring Chinook and Steelhead:** spawning: 13 - 15.5°C rearing: 15 - 17.5°C holding & migration: 15 - 17.5°C **Bull Trout:** incubation: <2°C or >6°C rearing: <4°C or 13 - 15°C spawning: <4°C or >10°C And temperatures in areas used by adults during migration sometimes exceed 15°C	**Spring Chinook and Steelhead:** spawning: >15.5°C rearing: >17.5°C holding & migration: >17.5°C **Bull Trout:** incubation: <1°C or >6°C rearing: >15°C spawning: <4°C or >10°C And temperatures in areas used by adults during migration regularly exceed 15°C (thermal barriers present)

Table 2.7. Reach-scale metrics.

Adequate	At Risk	Unacceptable
Pathway: Habitat Access		
General Indicator: Physical Barriers		
Specific Indicator: Main Channel Barriers		
No man-made barriers present in the mainstem that limit upstream or downstream fish passage at any flow.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.
Pathway: Habitat Quality		
General Indicator: Substrate		
Specific Indicator: Dominant Substrate / Fine Sediment		
Gravels or small cobbles make up >50% of the bed materials in spawning areas. ≤12%fines/sand (<2 mm) in spawning gravel.	Gravels or small cobbles make up 30-50% of the bed materials in spawning areas. 12-17% fines (<2 mm) in spawning gravel.	Gravels or small cobbles make up <30% of the bed materials in spawning areas. >17% fines (<2 mm) in spawning gravel.
General Indicator: Large Woody Material		
Specific Indicator: Pieces per Mile at Bankfull		
32 pieces/mile of large wood (diameter > 12 in, length > 35 ft). Adequate rating also indicates there are sources of woody debris available for both long- and short-term recruitment within the reach.	Current levels are able to maintain the minimum requirements for an "adequate" rating, but potential sources for long-term woody debris recruitment, as determined by the Riparian Structure reach metrics, are lacking in order to maintain these current levels.	Current levels are not meeting the minimum requirements for an "adequate" rating, and potential source of woody debris for short- and/or long-term recruitment are lacking as well.
General Indicator: Pools		
Specific Indicator: Pool Frequency and Quality; presence of large pools		
Pool frequency: Number of pools/mile for a given wetted or channel width. **Wetted width:** 15 – 20 ft, 39 pools/mi 20 – 30 ft, 23 pools/mi **Channel width:** 25 ft, 47 pools/mi To be considered adequate, at least 50% of the total pools are large pools >1 m (3 ft) deep. Pools must also have good fish cover (as determined by riparian vegetation and canopy cover metrics) and cool water with only a minor reduction in pool volume from fine sediment.	Pool frequency meets the values for the "adequate" rating, but pools have inadequate cover/temperature and/or there has been a moderate reduction of pool volume by fine sediment. Reaches have between 20-50% large pools (>1 m deep) present with good fish cover.	Pool frequency does not meet the pools/mile metric given in the "adequate" rating. Pools also have inadequate cover/temperature and/or there has been a major reduction of pool volume by fine sediment. Reaches have <20% large pools (>1 m deep).
General Indicator: Off-Chanel Habitat and Refugia		
Specific Indicator: Connectivity with Main Channel		
Reach has side channels and/or groundwater fed tributaries. Aquatic refugia such as backwaters,	Reach provides some aquatic off-channel and refugia features but access varies or is at risk of	Reach provides no or only minimal off-channel or in-channel refugia. Floodplains are disconnected by

Adequate	At Risk	Unacceptable
alcoves, large boulder eddies exist within the channel. Well-vegetated floodplains with healthy riparian community are inundated on a 1–2-year recurrence frequency. No man-made barriers along the mainstem that prevent access to off-channel areas	disconnection due to human impacts or man-made barriers. Floodplains along the off-channel habitat are well-vegetated with inundation recurrence of 2-5-years.	processes of incision and/or human structures (levee, bridges, etc.) and riparian vegetation has been altered.
Pathway: Riparian Vegetation		
General Indicator: Condition		
Specific Indicator: Structure		
>80% large trees (>21 in DBH; USFS 2013) in the riparian buffer zone (defined as a 100 ft buffer along each bank) based on habitat assessment data	50-80% large trees (>21 in DBH; USFS 2013) in the riparian buffer zone (defined as a 100 ft buffer along each bank) based on habitat assessment data.	<50% large trees (>21 in DBH; USFS 2013) in the riparian buffer zone (defined as a 100 ft buffer along each bank) based on habitat assessment data.
Specific Indicator: Disturbance (Human)		
<20% disturbance in the 200 ft riparian buffer zone (e.g., agriculture and grazing, residential, roads, etc.) and <2 mile/miles^2 road density in the 200 ft riparian buffer zone.	20-50% disturbance in the 200 ft riparian buffer zone (e.g., agriculture and grazing, residential, roads, etc.) and 2-3 miles/miles^2 road density in the 200 ft riparian buffer zone.	>50% disturbance in the 200 ft riparian buffer zone (e.g., agriculture and grazing, residential, roads, etc.) and >3 miles/miles^2 road density in the 200 ft riparian buffer zone.
Specific Indicator: Canopy Cover		
Trees and shrubs within one site potential tree height distance (~100 ft) have >80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have 50-80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have <50% canopy cover that provides thermal shading to the river.
Pathway: Channel		
General Indicator: Dynamics		
Specific Indicator: Floodplain Connectivity		
Floodplain areas are hydrologically linked to main channel within the context of the local process domain; overbank flows occur and maintain wetland functions, and riparian vegetation. Naturally confined channels are considered adequate.	Reduced linkage of floodplains and riparian areas to main channel in reaches with historically strong connectivity; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of floodplain soil accumulations and riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, floodplain, and riparian areas relative to historical connectivity; riparian vegetation/succession is altered significantly.
Specific Indicator: Bank Stability/Channel Migration		
Channel is migrating at or near natural rates within the geomorphic construct of the reach.	Channel migration is occurring at a faster or slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a

Adequate	At Risk	Unacceptable
		channel planform change, and sediment supply has noticeably increased from bank erosion.
Specific Indicator: Vertical Channel Stability		
No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach.	Measurable trend of aggradation or incision that has the potential to, but has not yet caused, disconnection of the floodplain or a visible change in channel planform (e.g., single thread to braided).	Enough incision or human infrastructure has occurred that the floodplain and off-channel habitat areas have been disconnected from the main channel; or enough aggradation has occurred to create a visible change in channel planform (e.g., single thread to braided).