A BIOLOGICAL STRATEGY TO PROTECT AND RESTORE SALMONID HABITAT WITHIN THE UPPER COLUMBIA RIVER BASIN

UCRTT

UPPER COLUMBIA REGIONAL TECHNICAL TEAM

September 2021

The Upper Columbia Regional Technical Team (UCRTT) consists of professional scientists working in various fields including ecology, systems ecology, restoration ecology, fisheries, hydrology, geomorphology, engineering, and modeling (see Attachment 1 for a listing of current UCRTT members). Although membership is non-representational, members are employed by federal, state, tribal, public utilities, conservation groups, and consulting firms. All members have extensive experience working in the Upper Columbia. As outlined in the UCRTT Operating Procedures, the UCRTT (1) recommends region-wide approaches to protect and restore salmonid habitat, (2) guides the development of and evaluates salmonid recovery projects within the Upper Columbia, (3) reviews and coordinates monitoring and evaluation activities to the extent possible, and (4) develops and guides salmonid recovery monitoring plans. The UCRTT receives support from the Upper Columbia Salmon Recovery Board (UCSRB) and their staff.

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Definitions and Acronyms

Assessment Unit (AU) – The sub-watershed used as the spatial currency in the Upper Columbia Biological Strategy's prioritization framework. In this document, an assessment unit is a USGS 12-digit or sub-watershed hydrologic unit.

CAC – Citizens' Advisory Committee.

Channel Migration Zone – Areas in a floodplain where a stream or river channel can be expected to move naturally over time in response to gravity and topography.

DPS – Distinct Population Segment.

Ecological Concern – Specific features of freshwater habitat and ecology that influence the productivity and abundance of salmonids that restoration projects are meant to address.

EDT – Ecosystem Diagnosis and Treatment model.

ESA – Endangered Species Act.

ESU – Evolutionarily Significant Unit.

Fluvial Geomorphic Processes – The physical processes that are responsible for the creation and arrangement of fluvial landforms. Geomorphic processes are governed by the flux of both water and sediment and their interactions with vegetation and geology. Also referred to as geo-fluvial processes.

Focal Species – A species that is the target of a management action or concern.

GIS – Geographic Information System.

ESA – Endangered Species Act.

Habitat Action Type – Refers to a classification of actions such as pool development, riparian fencing, barrier removal, boulder placement, etc. Action types are classified under categories such as protection, floodplain reconnection, riparian restoration, nutrient supplementation, etc.

HUC-12 – The smallest unit of the hierarchical division of the surface water of the United States as managed by the US Geological Survey and organized in the Nation Watershed Boundary Dataset. HUC-12 or sub-watershed is synonymous with Assessment Unit.

ICTRT – Interior Columbia Technical Recovery Team.

IT – Implementation Team.

Landscape Scale – The scale at which natural processes or anthropogenic factors affect an entire sub-watershed or sub-basin.

Limiting Factors – Specific features of freshwater habitat that influence the productivity, abundance, diversity, and spatial structure of salmonids and which restoration and protection projects are meant to address. This term is often used interchangeably with Ecological Concern.

MaDMC – Monitoring and Data Management Committee.

MaSA – Major Spawning Area.

MiSA – Minor Spawning Area.

Mitigation – Mitigation is the prevention of future undesired consequences; for example, the prevention of future water and resource degradation or the prevention of a spread of an invasive species. This is one of four pathways of river management action (Mitigation, Protection, Rehabilitation, and Restoration).

MPG – Major Population Group.

Prioritization – Process of ranking assessment units (HUC-12), reaches, limiting factors, and habitat action types (for both restoration and protection) to determine their relative biological priority for funding and implementation.

Process-based Restoration – Actions that will result in long-term changes to natural watershed and fluvial processes. Projects like riparian plantings, increasing flows, removing structures that limit floodplain connectivity are all examples of actions that restore natural processes.

Protection – Preservation of the current condition of the river ecosystem for the benefit of fish populations. This is one of four pathways of river management action (Mitigation, Protection, Rehabilitation, and Restoration).

Reach – One of the nested hierarchical subdivisions of a drainage network. It is smaller than a valley segment and larger than a channel unit. A reach is often classified by the geomorphic attributes of valley confinement, bed material, channel geometry, slope, and assemblages of geomorphic units (e.g., pool, riffle, etc.). Reaches in the Upper Columbia are set to be 1-4 km long.

Reach Assessment – A rigorous evaluation of both the current *and* historical geomorphic condition of one or more valley segments (one or more reaches) within an individual stream. The assessment quantifies rates of geomorphic and hydrologic change and identifies the processes that are responsible for both historical and current habitat condition. Reach assessment results provide a quantitative foundation for identifying appropriate strategies to improve or protect salmonid habitat.

Rehabilitation – One of four pathways of river management action (Mitigation, Protection, Rehabilitation, and Restoration) where some of the attributes of the unimpaired, pristine condition of the river are established. Because restoration is often not feasible, rehabilitation (also referred to as enhancement) is often the pathway of intervention that will lead to the largest ecosystem improvement, ecologic function, and geomorphic condition.

Restoration – Restoration is the full recovery of the physical processes that were responsible for the geomorphology and distribution fish habitat before Euro-American settlement of the study area. It is the return to a pristine or unimpaired geomorphic condition and ecosystem and may require the most amount of human intervention.[1] This is one of four pathways of river management action (Mitigation, Protection, Rehabilitation, and Restoration).

RM&E – Research, Monitoring, and Evaluation.

DPS – Distinct Population Segment.

SRFB – Salmon Recovery Funding Board.

UCRTT – Upper Columbia Regional Technical Team

UCSRB – Upper Columbia Salmon Recovery Board.

WAT – Watershed Action Team.

VSP – Viable Salmonid Population.

[1] Restoration is often used interchangeably with enhancement, rehabilitation, mitigation, creation, and improvement. Strictly speaking, these terms do not mean the same thing. Nevertheless, this document uses the term restoration to mean actions that enhance, rehabilitate, mitigate, create, or improve habitat conditions.

Introduction

The purpose of this document is to outline biological considerations for the protection and restoration of salmonid habitat in the Upper Columbia region. This document provides a technical foundation and justification for setting priorities based on available information and professional judgment. This document represents the Upper Columbia Regional Technical Team's (UCRTT) strategy to support and guide the implementation of the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan* (UC Salmon and Steelhead Recovery Plan) and the *Recovery Plan for the Coterminous United States Population of Bull Trout* (Mid-Columbia Bull Trout Implementation Plan).

Because this strategy is intended to support the implementation of recovery plans, focal species addressed in this document include those listed for federal protection under the Endangered Species Act (ESA) including spring Chinook Salmon (*Oncorhynchus tshawytscha)*, steelhead (*O. mykiss*), and Bull Trout (*Salvelinus confluentus)*. Other species of interest include summer Chinook Salmon (*O. tshawytscha*), Sockeye Salmon (*O. nerka*), Westslope Cutthroat Trout (*O. clarki*), and Pacific Lamprey (*Entosphenus tridentada)*. This strategy also recognizes the ongoing reintroduction of Coho Salmon (*O. kisutch*) to the Wenatchee and Methow sub-basins and the reintroduction of spring Chinook Salmon into the Okanogan sub-basin. The UCRTT believes that protecting and restoring habitat for ESA-listed species will also benefit other species of interest.

This document follows a logical structure. After a brief description of the Upper Columbia Region, this document describes the viable salmonid population framework, which provides a working definition for a naturally, self-sustaining population. The document then provides the scientific foundation for restoration and protection work in the Upper Columbia. This section focuses on the concept of restoring natural processes and places restoration and protection work within the context of watershed processes rather than haphazard actions scattered across the landscape. The document then summarizes the Upper Columbia Prioritization Strategy, which identifies appropriate actions within high priority areas for protection and restoration. Next, the document provides guidance on conducting reach assessments and identifies the need for research, monitoring, and evaluation (RM&E). These are important components of the Biological Strategy and provide information for the prioritization process. Finally, the document describes the UCRTT's project evaluation process for proposed protection and restoration actions in the Upper Columbia.

The UCRTT encourages project sponsors to use the Biological Strategy and supporting tools to identify the locations and types of projects with a high likelihood of providing biological benefit for the recovery of ESA-listed salmonids. The goal of the UCRTT is to provide information that will be used to improve abundance, freshwater productivity, spatial structure, and diversity of ESA-listed species and other species of concern (e.g., summer Chinook Salmon and Pacific lamprey). *Simply put, this strategy is designed to help project sponsors implement the right project in the right place at the right time.*

Upper Columbia Region

The geographic scope of the Biological Strategy is the Upper Columbia region (Figure 1). This region is comprised of the mainstem Columbia River and its tributaries upstream of the Yakima River to the tailrace of Chief Joseph Dam, including six major sub-basins: Crab Creek, Wenatchee River, Entiat River, Chelan River, Methow River, and Okanogan River sub-basins. This area captures the extant major population groups (MPG) of the Upper Columbia spring Chinook Salmon Evolutionarily Significant Unit (ESU) (Wenatchee, Entiat, and Methow) (Figure 2), the Wenatchee, Entiat, and Methow core areas of the Mid-Columbia Recovery Unit for Bull Trout (Figure 3), and the extant major population group (MPG) of the Distinct Population Segment (DPS) (Crab Creek, Wenatchee, Entiat, Methow, and Okanogan) for Upper Columbia summer steelhead (Figure 4). The region does not include areas inaccessible to migrating fish upstream of Chief Joseph Dam that were anthropogenically blocked. At this time, this report does not consider actions and recommendations for streams and watersheds downstream of Rock Island Dam.

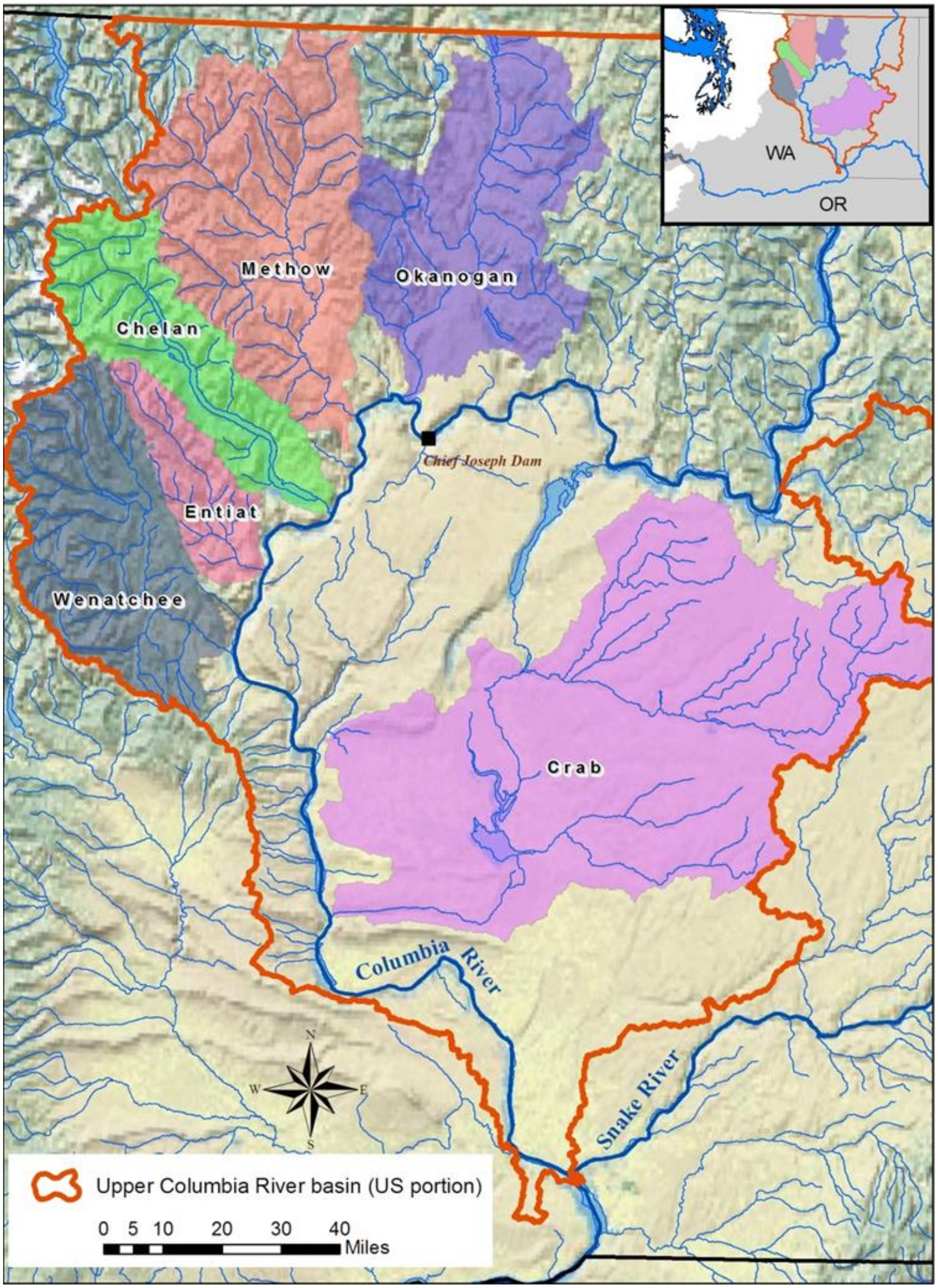

Figure 1. Map of the Upper Columbia region.

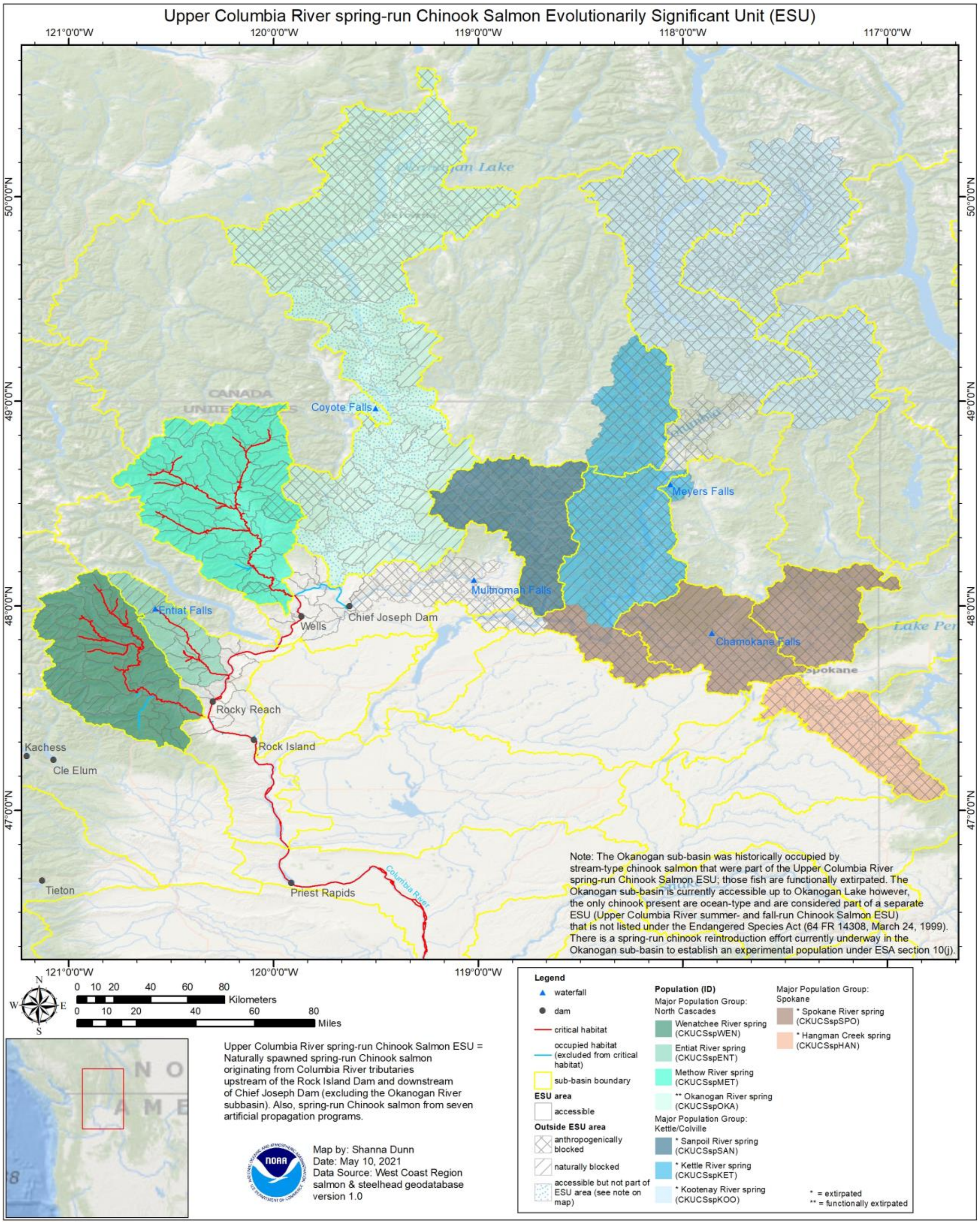

Figure 2. Map of the Upper Columbia River spring Chinook Salmon population structure.

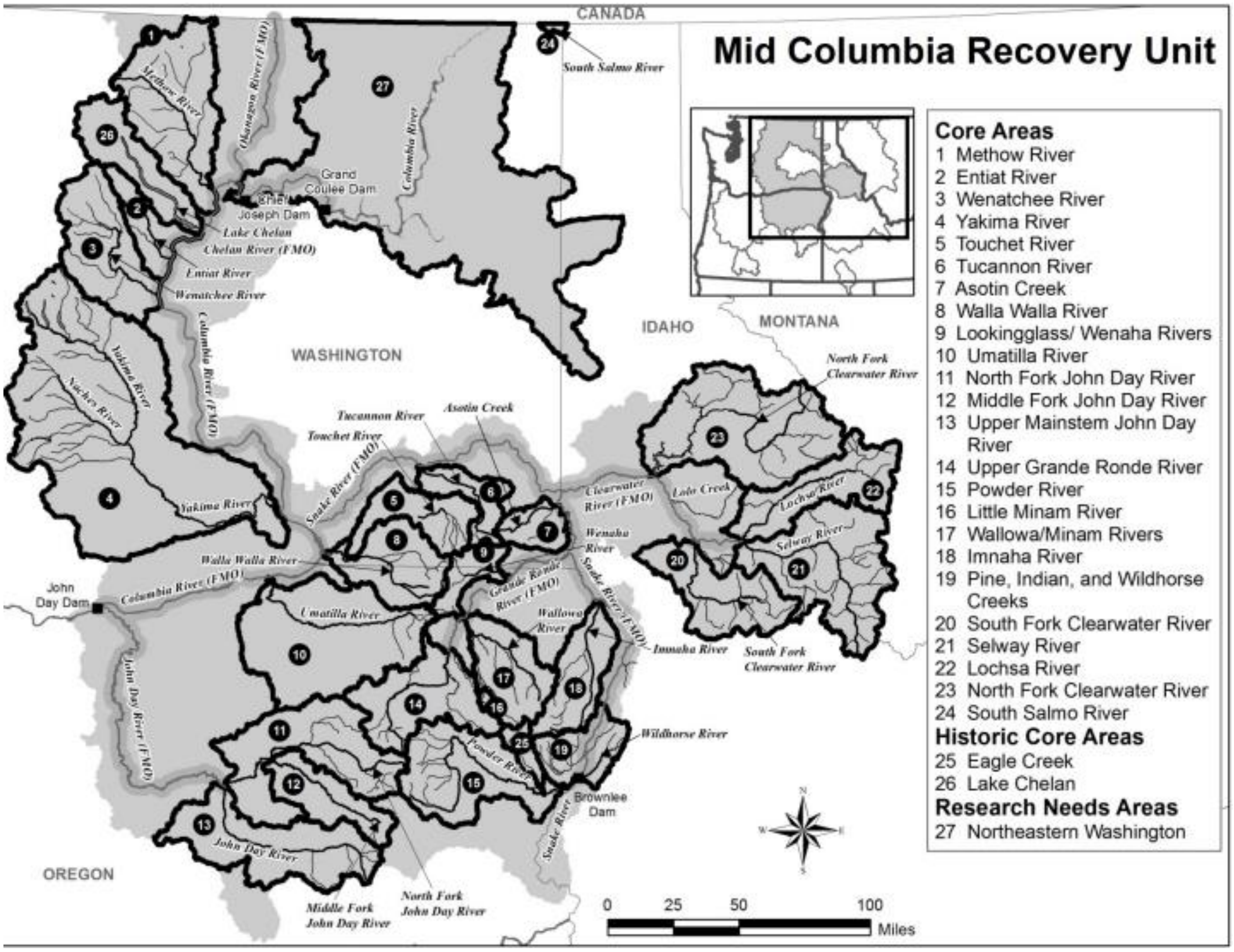

Figure 3. Map of the Mid-Columbia Recovery Unit core areas for Bull Trout.

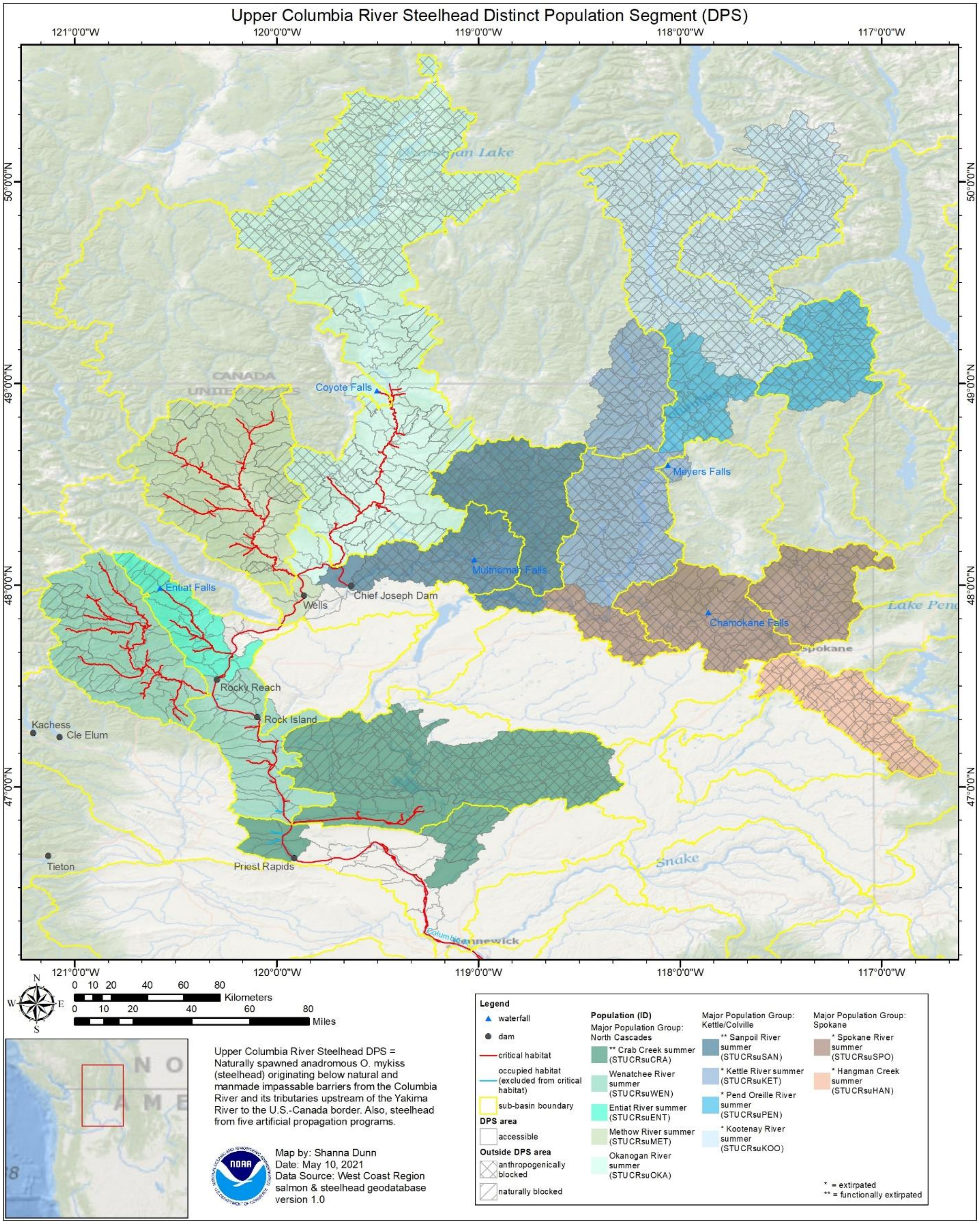

Figure 4. Map of the Upper Columbia River steelhead population structure. Data collected by the Colville Tribes indicate that summer steelhead use habitat in Canada and are found in Inkaneep and Vassuex creeks as well as in the mainstem Okanagan River to Lake Okanagan.

Viable Salmonid Population Framework

The Biological Strategy is designed to guide implementation of habitat actions identified in the recovery plans. As such, the UCRTT has adopted the viable salmonid population (VSP) framework, which was largely developed by McElhany et al. (2000) and used by the Interior Columbia Technical Recovery Team (ICTRT 2007, 2008) to evaluate the status and extinction risks of spring Chinook Salmon and summer steelhead in the Upper Columbia. Thus, it provides an excellent framework for the Biological Strategy.

By definition, a viable salmonid population is naturally self-sustaining with a high probability of persistence over a 100-year time period (McElhany et al. 2000; ICTRT 2007). To determine whether a population is self-sustaining and has a low probability of extinction, four VSP parameters are evaluated for each population: abundance, productivity (population growth rate), spatial structure, and diversity (ICTRT 2007). These are defined as follows:

> *Abundance* is the number of fish produced by natural processes. These are fish that have spent their entire life cycle in nature and are referred to as "natural-origin fish." Natural-origin fish originate from naturally spawning parents (these can be natural-origin or hatchery-origin fish). They hatch in a stream and survive to spawn naturally themselves years later.
>
> *Productivity* is a measure of reproductive effectiveness at the population level. Typically, it is stated as the number of adult offspring (recruits; which includes the number of adults harvested, adults taken for broodstock, and the number arriving on the spawning grounds) produced per parent (spawner). Although it is used as an indicator of population health and resilience, it is only appropriate to do so if it has been standardized for two confounding effects: (1) yearly variation in survival rates (e.g., marine conditions) and (2) yearly variation in the density of spawners relative to habitat capacity. Once standardized for these two confounding effects, values obtained for population productivity are indicative of a population's resilience and likelihood of persistence. A population with a low standardized productivity is at greater extinction risk than one with a high standardized productivity.
>
> *Spatial structure* is the range or distribution of natural-origin fish (adult spawners) within the geographic area of the population. Any viability evaluation must consider spatial structure within a population (or group of populations) because spatial structure affects extinction risk (McElhany et al. 2000).
>
> *Diversity* refers to the distribution of traits within and among populations. For anadromous salmonids, these traits include anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, physiology, and molecular genetic characteristics. A combination of genetic and environmental factors largely causes phenotypic diversity. Variation or diversity in these and other traits is important to viability because (1) it allows fish to successfully use a

wider array of environments; (2) it reduces the risks posed by random natural events (e.g., different ocean distribution patterns indicate that not all fish are at risk from local or regional varying ocean conditions); and (3) genetic diversity allows fish to adapt to changing environmental conditions. Habitat, harvest, and hatchery factors can all affect diversity.

The structure for determining salmon and steelhead viability is hierarchical (ICTRT 2007). It is comprised of major spawning areas (MaSA) within watersheds that collectively make up independent populations. Several closely related populations form major population groups (MPGs), which, when combined, make up a DPS or ESU (Figure 5). Thus, viability and recovery are ultimately determined at the DPS and ESU scales.

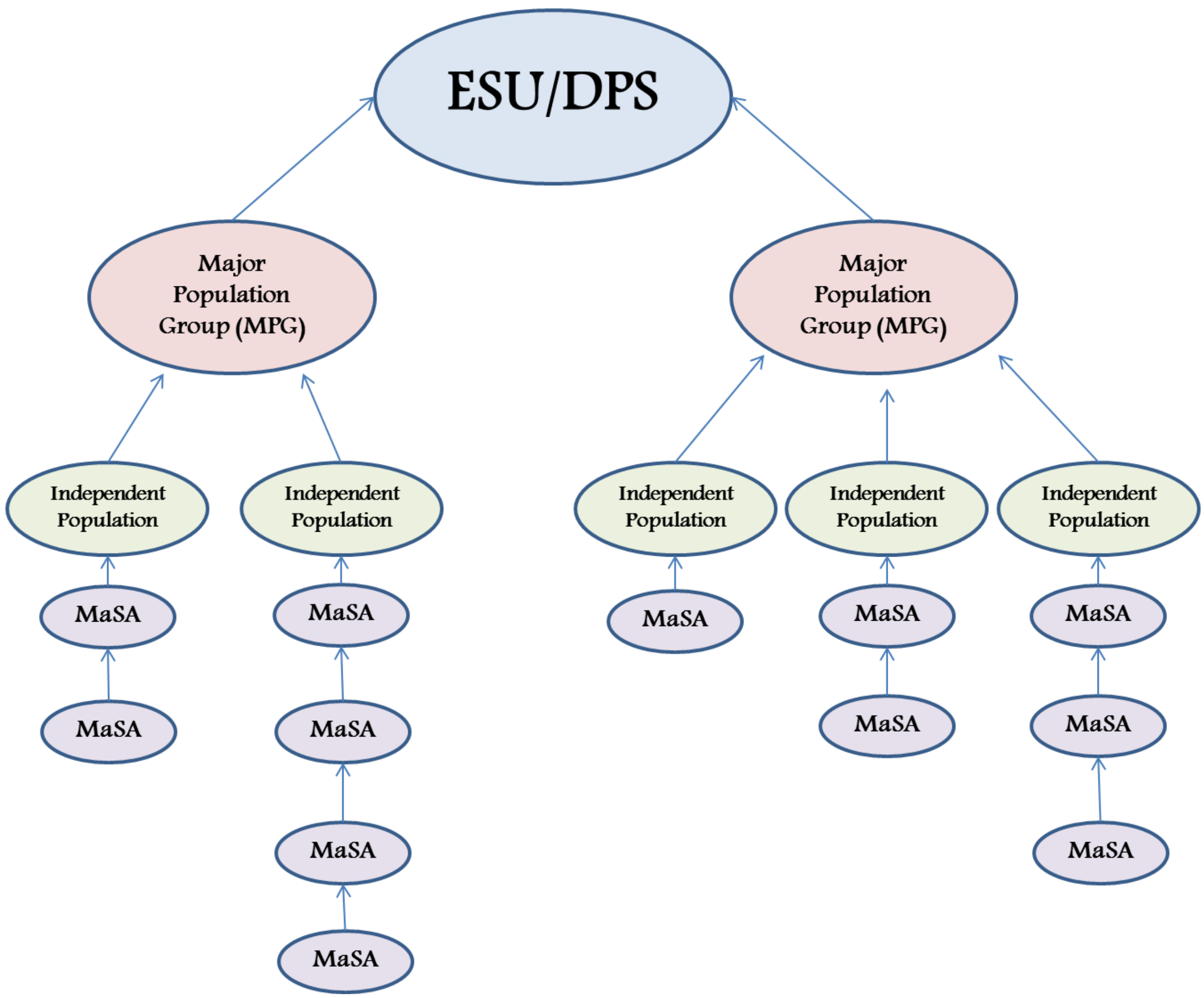

Figure 5. Overview of the hierarchy for the components of ESU and DPS viability.

The ICTRT (2007) established four size categories for spring Chinook Salmon and summer steelhead populations based on intrinsic potential[2]: Basic, Intermediate, Large, and Very Large. The ICTRT (2007) then assigned species-specific minimum abundance and productivity thresholds associated with the categorizations. In the Upper Columbia, the population-viability criteria for each population of spring Chinook Salmon and summer steelhead are shown in Table 1.

Table 1. Hierarchical organization and abundance and productivity thresholds for spring Chinook Salmon and summer steelhead populations within the Upper Columbia Region (from the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*).

ESU or DPS	Major Population Grouping	Independent population	Minimum abundance threshold	Productivity threshold
Upper Columbia Summer Steelhead DPS	East Cascades	Wenatchee	1,000	1.1
		Entiat	500	1.2
		Methow	1,000	1.1
		Okanogan[a]	500	1.2
		Crab Creek	Not defined	
	Spokane River	Not defined (extinct)		
	Kettle/Colville/Sanpoil	Not defined (extinct)		
Upper Columbia Spring Chinook ESU	East Cascades	Wenatchee	2,000	1.2
		Entiat	500	1.4
		Methow	2,000	1.2
		Okanogan	Not defined (extinct)	
	Spokane River	Not defined (extinct)		
	Kettle/Colville/Sanpoil	Not defined (extinct)		

[a] The viability criteria for Okanogan steelhead are only for the US portion of the population.

The framework described above is specific to spring Chinook Salmon and summer steelhead. A similar framework was developed by the U.S. Fish and Wildlife Service for Bull Trout (USFWS 2015). That framework also includes VSP parameters but with some differences. The USFWS Bull Trout Recovery Plan (USFWS 2015) seeks to address threats and physical or biological needs of Bull Trout throughout its range and focuses on range-wide recovery needs but does not focus on specific measures of population abundance. This approach to achieving recovery is intended to ensure adequate conservation of genetic diversity, life history features, and broad geographic representation (i.e., adequate spatial distribution) of Bull Trout populations in the six recovery units that comprise the coterminous population of Bull

[2] Intrinsic potential was based on available Geographic Information System (GIS) data layers showing stream characteristics (e.g., channel width, gradient, valley confinement) and empirically derived relationships between habitat type, stream structure, landscape processes, and spawning.

Trout. The Mid-Columbia Recovery Unit Implementation Plan focuses on a threats-based approach to improving population viability (USFWS 2015).

Following the VSP framework, the UCRTT provides guidance on identifying tributary habitat actions that are expected to contribute to improved status of the VSP parameters. However, factors other than tributary habitat conditions may limit the response of focal species to those actions. For example, improving the quality and quantity of summer and winter rearing habitat should increase population productivity by improving egg-to-smolt survival of anadromous salmonids. However, increases in spawners may not be realized if survival outside the tributaries decreases during the same time period. Likewise, spawner composition comprised of high proportions of hatchery-origin fish on the spawning grounds has been identified in the Recovery Plan as a high-risk factor for diversity and productivity throughout the Upper Columbia, but improvements to tributary habitat will not directly affect spawner composition, which may require the reform of hatchery programs. Therefore, the Biological Strategy focuses on within-sub-basin habitat improvements that increase freshwater survival of populations because hatchery reform and factors affecting survival outside of the Upper Columbia tributaries are not within the purview of this document.

Foundation for the Biological Strategy

The UCRTT defines *natural stream/watershed processes* as dynamic processes affecting habitat form and function at multiple spatial and temporal scales. Connectivity to the floodplain, complex instream structure, absence of migration barriers, and large, intact riparian zones are all features of natural stream/watershed processes. In general, the first priority of the UCRTT is to protect existing natural stream/watershed processes where they exist. If that is not possible, the only option available is to restore natural processes to the extent possible, or in some cases to enhance habitat. *Process-based restoration* refers to projects that will result in long-term changes to natural watershed and fluvial processes (Sedell and Beschta 1991; Beechie et al. 2010; Ciotti et al. 2021). Another way to look at process-based restoration is that it addresses the cause or source of the impairment, and not just the symptom. Projects like riparian plantings, increasing flows, removing migration barriers, and removing structures that limit floodplain connectivity and channel migration are all examples of actions that restore natural processes (Beechie et al. 2010; Ciotti et al. 2021).

To implement successful restoration projects, one must understand the geomorphic and ecological processes that shape and form the river and associated landscapes. Many restoration projects fail because of a misunderstanding of or lack of consideration for natural processes operating at various spatial and temporal scales and how human activities and other factors affect or control those processes (Frissell and Nawa 1992; Roni et al. 2002). Because these factors and processes operate at multiple spatial and temporal scales, restoration ecologists and practitioners must view the river holistically as a continuous "riverscape" (Fausch et al. 2002; Allan 2004). The basis of the riverscape construct is that ecosystem processes operating at different scales form a nested, interdependent system where one level influences other levels. Thus, an understanding of one level is greatly informed by those levels above and below it. Furthermore, many processes that create habitat operate on time scales of decades or longer (e.g., channel migration and the formation of off-channel habitat) (Leopold et al. 1992). Interrupting natural ecosystem processes can result in the loss of fish habitat over multiple time scales (Allan 2004).

In simple terms, one can view the riverscape at three interconnected spatial scales: the geographic scale (e.g., population scale), the sub-watershed scale, and the reach scale (Naiman et al. 1992; Montgomery and Buffington 1998). At the geographic (population) scale, factors such as geology, soils, vegetation, and climate serve as ultimate "top down" spatial controls (Leopold et al. 1992; Montgomery and Bolton 2003). These factors operate over large areas, remain stable over relatively long time periods, and act to shape the overall character and attainable conditions within a sub-watershed or basin. Factors at the sub-watershed scale are a function of geographic-scale factors and refer to more local conditions of geology, landform, and biotic processes that operate over smaller areas and shorter time periods and can be viewed as "bottom up" spatial controls. These factors include processes such as stream flows, temperature, sediment input, and channel migration. Factors operating at both the geographic and sub-watershed scales serve to define flow (water and sediment) characteristics, which in turn shape habitat/reach-scale characteristics within broadly predictable ranges. Reach-scale factors include pool-riffle ratios, channel size, riparian vegetation, substrate composition, large woody debris, and bank stability. This is the scale at which fish species exploit resources and reproduce. This is also the scale at which most restoration occurs (Fausch et al. 2002).

Human activities that disrupt natural sub-watersheds tend to act on sub-watershed processes that form suitable habitat conditions at the reach scale (Opperman et al. 2005). For example, human activities can alter connectivity and the delivery of woody debris, water, sediment, and nutrients to a stream (Gregory et al. 2003; Stockner 2003; Opperman et al. 2005). Interruption of these processes reduces habitat quality and quantity at the reach scale by decreasing spawning and rearing space, food, and migration corridors. Therefore, restoration actions can focus on processes that affect sub-watersheds or on habitats themselves (Figure 6). For example, some restoration techniques, such as re-vegetation, road removal, and establishing normative stream flows focus on restoring natural processes at the sub-watershed scale. These techniques affect sediment supply, delivery of organic material, and channel migration. In contrast, other techniques focus on manipulating or enhancing habitat directly. Examples include wood and boulder placement, nutrient enrichment, and creating new habitat (Gregory et al. 2003; Stockner 2003; Morley et al. 2005). Unless well planned, with an in-depth understanding of ultimate controls and processes across multiple spatial and temporal scales, most habitat-enhancement actions tend to be relatively short lived if the disruption of the underlying process is not corrected (Fausch et al. 2002).

Successful restoration requires a holistic approach that considers processes operating at multiple spatial and temporal scales (Figure 6). A watershed or ecosystem assessment of current and historical conditions and disrupted processes can be used to identify restoration opportunities consistent with reestablishing the natural processes and functions that create habitat (Roni et al. 2002; Beechie et al. 2013; Ciotti et al. 2021). It is also helpful in determining the appropriate sequencing of restoration actions and prioritizing actions (Roni et al. 2002; Roni et al. 2013a). In general, restoration of watershed processes should precede or be conducted in conjunction with habitat enhancement. This is not to say that habitat enhancement techniques are inappropriate, but rather to emphasize the importance of coupling enhancement efforts with restoration of watershed processes. Clearly, in some locations (e.g., heavily developed areas), restoration of watershed processes may not be feasible. Habitat enhancement techniques may be the only solution in these areas. In other areas, habitat enhancement techniques may address watershed processes and therefore are appropriate restoration measures.

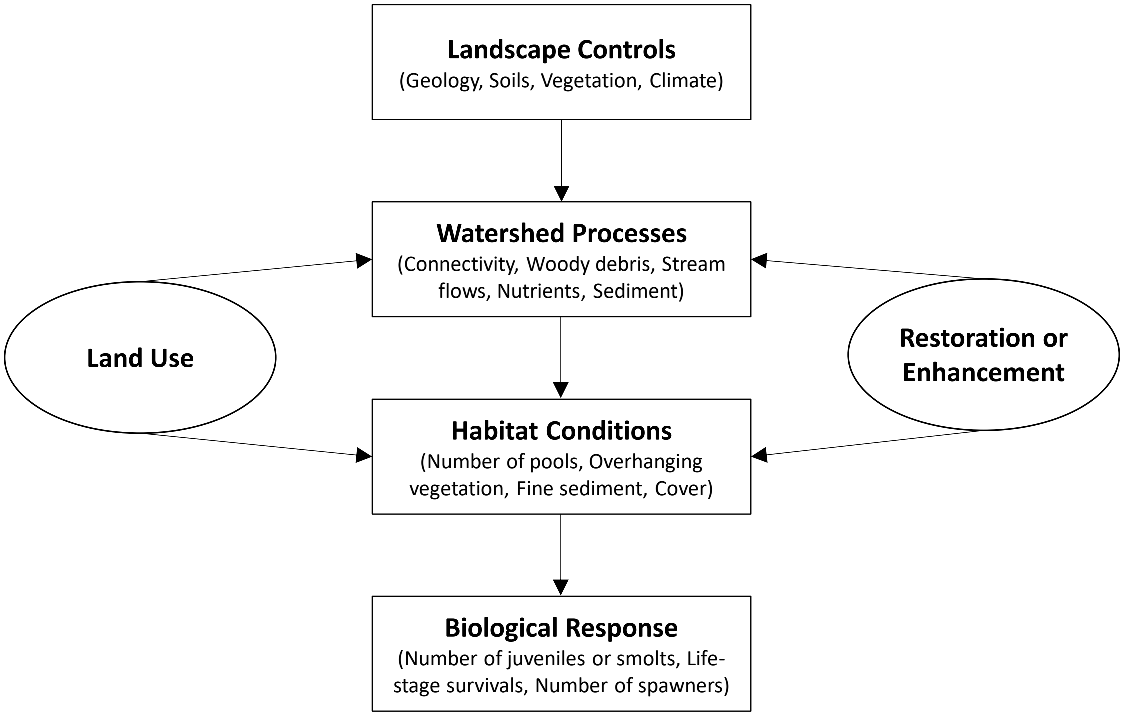

Figure 6. Simple model showing linkages between landscape controls and watershed processes, and how land use and restoration or enhancement can influence habitat and biota (modified from Roni 2005).

Restoration Approach

The UCRTT believes the focus of restoration should be on restoring watershed and habitat function, addressing limiting factors, and opening blocked habitat. As described in the prioritization section, the UCRTT recommends a range of actions for habitat restoration in the Upper Columbia based on promoting properly functioning geo-fluvial processes that control habitat diversity, instream flows, and water quality throughout the watershed. Most of these efforts will be on higher-order stream reaches and aggradation zones (typically unconfined areas of low stream gradient where deposition of substrate materials occurs). Restoration in these areas will benefit a broad range of species and populations. Importantly, actions that rectify the sources of the habitat degradation can have more benefits to biological productivity in the long run than addressing specific instream complexity needs (Bellmore et al. 2019).

In some situations, restoration projects may accomplish both short-term (habitat enhancement) and long-term (restoration of natural processes) objectives. For example, adding large wood to the stream may increase salmonid habitat in the near term, while promoting natural processes such as channel migration, sediment sorting, riparian revegetation, and floodplain activation over the long term. The UCRTT recognizes that these projects can be biologically effective when the initiation of the short-term strategy has been integrated with the long-term strategy and designed and implemented in accordance with the sequencing and prioritization determined from an appropriate assessment (see Prioritization Strategy and Assessment sections).

Some of the most foundational restoration actions that can be taken include the restoration of flows in dewatered areas and the removal of fish passage barriers to open blocked habitat. Additionally, some Upper Columbia streams need increased flows to address chronic sources of mortality to salmonids; although, inadequate flows may occur naturally in some areas (such as the upper Methow). Diversion of water for out-of-stream uses (principally for irrigation and municipalities) is the most tangible impact to instream flow needs for fish. In addition, degradation of floodplain (and some upland) habitats exacerbates the range of seasonal flows in all Upper Columbia sub-basins, which may dramatically reduce the productivity and expression of diverse life histories in salmonid populations.

Protection Approach

The UCRTT believes the highest priority for protecting biological productivity should be to protect and allow natural geo-fluvial processes such as unrestricted stream channel migration and sediment transport, instream complexity, and floodplain function. The primary means to meet this objective is to protect the channel-migration zone[3] and the riparian area beyond the channel-migration zone, especially when these features are functioning at a high level. Also important is the protection of watershed process through the management of upland areas that maintain downstream habitat.

Predetermined riparian protection measures (i.e., buffer strip widths) for each site may not be biologically effective because riparian function depends on site-specific considerations including channel type, size, aspect, dominant tree/canapy species, floodplain character, presence of wetlands or off-channel features, and the potential for channel migration. Some areas have more acute needs for protection because they may be within significant spawning or rearing areas or may be at imminent risk to future habitat degradation. In general, habitat protection should target the highest functioning habitat at the greatest risk of degradation, or those areas with the greatest potential for maintaining geo-fluvial processes.

Protection of high-quality habitat is inherently a defensive action, and while helping to prevent salmonid production from getting worse, does not provide a net overall gain in production. Therefore, focusing salmon recovery funds entirely on protection would not lead to recovery because degraded habitats would remain such without purposeful restoration efforts. The UCRTT believes that the most effective

[3] Channel migration zones are areas in a floodplain where a stream or river channel can be expected to move naturally over time in response to gravity and topography.

model for implementing both protection and restoration actions would rely on regulatory measures for protecting functional habitat and devote limited recovery funds to the restoration of degraded geo-fluvial processes and habitats. Unfortunately, deficiencies in existing land-use regulations and their enforcement hinder the use of this model in practice, and restoration dollars must be applied to protection measures to arrest continued decline in the availability of quality habitat.

It has been a challenge for the UCRTT to craft recommendations that balance the pressing needs for both protection and restoration actions. Pragmatism dictates a benefits-based solution to this dichotomy because recovery is the goal. Therefore, the following section describes the Prioritization Strategy and web-based tools that identify high-priority protection and restoration actions in high-priority areas within the Upper Columbia. The Prioritization Strategy balances the need for both protection and restoration actions.

Prioritization Strategy

Restoring and maintaining the productivity of salmon, steelhead, and bull trout habitat in the Upper Columbia requires a prioritization of tributary habitat actions to maximize the benefits derived from limited funding. The UCRTT defines prioritization as the process of ranking assessment units (HUC-12), 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 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*. The Prioritization Strategy provides a transparent prioritization process that will assist restoration practitioners and managers with decision making. The Prioritization Strategy is built on the VSP framework and Biological Strategy foundation described earlier and was informed by the work of Roni et al. (2002), Beechie et al. (2008), Roni et al. (2013a, 2013b), Rieman et al. (2015), BPA (2015), and Roni et al. (2018). This section provides a brief overview of the Prioritization Strategy. The Prioritization Strategy document, web tools, and products can be found on the Upper Columbia Salmon Recovery Board Prioritization Portal.

The Prioritization Strategy includes several important steps (Figure 7). The first step involves prioritizing and ranking assessment units and identifying priority life stages within each sub-basin (i.e., Wenatchee, Entiat, Methow, and Okanogan)[5]. In this step, the UCRTT used standardized procedures to define assessment units within each sub-basin and identified metrics and scoring rules to prioritize areas for restoration and protection. Assessment Units were assigned a category for each species of Tier 1 = High Priority, Tier 2 = Moderate Priority, and Tier 3 = Low Priority or “Not a Priority” for protection and restoration. This step also entailed prioritizing life stages for each species at the HUC 12 (assessment unit) scale.

The second step includes multiple pathways leading to high-priority restoration or protection actions at the reach scale. For restoration, reaches in high-priority (Tier 1) assessment units were prioritized using three pathways: one pathway focused on improving overall habitat conditions and function, another focused on implementing actions that address limiting factors for high priority life stages, and the last addressed fish migration barriers. Similarly, under this step, protection prioritization included two pathways: one focused on protecting high-quality areas to maintain overall habitat conditions and function, while the other focused on protecting habitat important to high-priority life stages. Once

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

[5] Because of a lack of information, several of the smaller tributaries to the Columbia River will receive less attention at this time. Once the UCRTT has more information on the smaller tributaries to the Columbia River, they will be included in the prioritization process. In addition, because of the large amount of restoration work conducted by Chelan County Public Utility District in the Chelan River, this area will not be evaluated for prioritization at this time.

priority reaches, limiting factors, and actions were identified, other considerations such as landowner willingness, cost, complexity, and societal issues[6] came into play in the final step. In total, the strategy incorporates biological, physical, economic, and sociopolitical criteria.

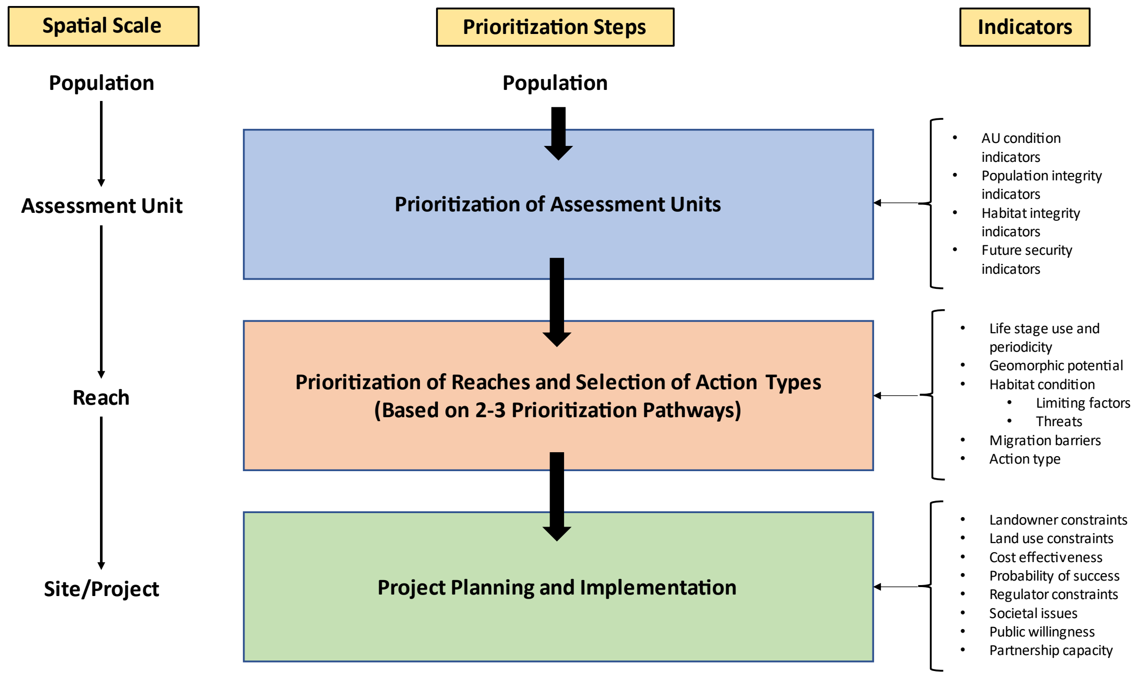

Figure 7. Stepwise process for selecting habitat actions for restoration and protection. In the second step, identification of restoration actions includes three pathways: habitat condition and function pathway, factors limiting priority life stages pathway, and migration barriers pathway. Identification of protection actions includes only the habitat condition and function pathway and factors limiting priority life stages pathway.

The UCRTT is responsible for completing and updating the first two steps of the strategy. The UCRTT partners, including UCSRB staff, Watershed Action Teams (WATs), Implementation Team (IT), and local project implementers, provided input and reviews throughout the development of those steps. Conversely, the UCRTT supports the WATs, IT, and others in determining the feasibility of implementing the prioritized list of action types within high-priority areas. Thus, the final step is largely the responsibility of the WATs and IT.

The final product of the Prioritization Strategy is a list of reach-specific, high-priority action types (restoration and protection) that if implemented should provide the greatest benefits to listed species[7].

[6] 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.

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

Information is contained in tables and on geospatial maps, hosted by the Upper Columbia Salmon Recovery Board, that is available to funders and sponsors. The prioritization tool and all data used are contained in excel spreadsheets and R-code housed on the UCSRB prioritization portal.

Importantly, the UCRTT understands there is additional information available in the region that can be used to prioritize and plan restoration and protection actions in the Upper Columbia. In particular, information from the Ecosystem Diagnosis and Treatment (EDT) model in the Okanogan and Methow River sub-basins and information contained in reach assessments (see below) can be used as a complement to the prioritization outputs. These assessments, models, and other tools were used to inform prioritization. The RTT believes project sponsors should use these resources when developing projects designed to improve habitat conditions in the Upper Columbia.

Assessments

The Prioritization Strategy summarized above relies heavily on assessments, monitoring data, and modeling results. Assessments provide valuable information on habitat, geomorphic processes, ecological interactions, and human history, which are needed to inform project development and management decisions. Although there are many types of assessments, this section of the Biological Strategy focuses on one type of assessment used broadly within the Upper Columbia – Reach Assessments.

The UCRTT defines a reach assessment as a rigorous evaluation of both the current *and* historical geomorphic condition of one or more valley segments (one or more reaches) within an individual stream. The assessment quantifies rates of geomorphic and hydrologic change and identifies the processes that are responsible for both historical and current habitat conditions at the reach scale. Reach assessments provide a quantitative foundation for identifying appropriate strategies to improve or protect salmonid habitat. The assessment of physical habitat should incorporate an evaluation of processes operating across a range of spatial scales from a geologic province to sub-watershed, valley segment, reach, and finally a geomorphic unit. Evaluation of processes across the spectrum of scales will provide information to support the identification of restoration or protection activities at discrete locations, while considering broader-scale physical, ecological, and anthropogenic influences.

Numerous reach assessments have been completed over the past several decades. Most priority restoration reaches in the Upper Columbia have completed reach assessments. A list of reach assessments and links to the assessment documents can be found in the UCSRB library. The UCRTT believes it is important that all data and results from reach assessments be made available to the public.

To help guide future reach assessments, the UCRTT developed a Reach Assessment Guidance Document that describes the assessment process. The guidance document describes the assessment framework, tools, data sources, reach assessment components, and use of reach assessment information. The guidance document can be found through this link: RTT Reach Assessment Guidance.

Research, Monitoring, and Evaluation

The UCRTT believes a robust research, monitoring, and evaluation (RM&E) program is needed to assist in identifying and prioritizing restoration and protection actions (e.g., inform the regional prioritization tool), evaluate the success of implemented habitat actions, track changes in fish populations and habitat conditions over time, and to better document the effects of climate change, density dependence, carrying capacity, metapopulation dynamics, and the presence and spread of exotic species on restoration actions and opportunities. Data needs in the Upper Columbia fall into several categories that are tied to the Endangered Species Act delisting criteria and to the recovery plans. The UCRTT's Monitoring and Data Management Committee (MaDMC) tracks the status of each of these categories in terms of current efforts and outstanding needs for data collection in the annual Upper Columbia Data Gaps List.

> *Population Status and Trends* – A core understanding of the status of the populations and their viability in space and time is essential to decision making and therefore is a high priority for data collection and analysis in the Upper Columbia. The UC Recovery Plan poses numerous questions related to the status and trends of core VSP parameters. To adequately answer these questions, a consistent, robust monitoring effort must be implemented. Data related to VSP parameters are essential for informing delisting decisions and UCRTT prioritization efforts.
>
> *Limiting Factors* – This type of monitoring is needed to assess potential limiting factors across the entire life cycle and across all "H's"- habitat, hatcheries, hydropower, and harvest. The goal is to identify potential limiting factors and evaluate whether the primary factors limiting the status of the population/ESU/DPS are increasing or decreasing over time. This information provides valuable information about what habitat attributes are currently limiting productivity and survival of Upper Columbia populations and what other factors impede the survival and recovery of UC salmon, steelhead, and Bull Trout. Potential limiting factors such as climate change, fish passage, habitat quality, invasive species, predation, and harvest should be evaluated and tracked over time along with other important potential sources of mortality.
>
> *Project Implementation* – Implementation monitoring answers the basic questions: (1) were tributary habitat actions implemented as planned, (2) did the actions do what they were designed to do, and (3) is the action performing as expected? This level of monitoring should be required for all habitat actions implemented within the Upper Columbia.
>
> *Effectiveness* – Effectiveness monitoring is needed to determine the benefits of habitat actions. It addresses habitat and in some cases fish responses. The UCRTT believes this work should focus on effectiveness of habitat projects incorporating spatial and temporal influences on results and at the appropriate scale (e.g., project, reach, assessment unit, or population) (see Hillman et al. 2016, 2018). Although information is now available on the effectiveness of some

types of projects at certain scales (e.g., project scale), there are outstanding questions regarding the effectiveness of riparian and floodplain restoration actions at the reach scale. However, the scale at which inferences about restoration effectiveness can be made may depend on the specific study system (Polivka et al. 2019) and the methodology used in RM&E (Polivka and Claeson 2020). It is important to understand the effects of various restoration approaches and techniques and what conditions dictate the success of one method over another. Projects should be evaluated based on their success at meeting the pre-defined goals and objectives for fish and habitat.

RM&E provides critical information for modeling efforts such as EDT and life-cycle modeling. Monitoring data are also important to the Prioritization Strategy; however, because of the lack of current habitat status and trend data, the UCRTT designed the Prioritization Strategy to function without detailed monitoring data. *The UCRTT believes it is essential to make decisions, while acknowledging uncertainty, rather than waiting until the ideal information is available.* This does not negate the importance of RM&E. Information from RM&E reduces the uncertainty in decision making and provides the means to evaluate the effectiveness of the Prioritization Strategy and inform future management decisions.

Evaluation of Proposed Habitat Actions

It is not only important to develop a Prioritization Strategy, but also to develop criteria for evaluating proposed restoration and protection actions. The UCRTT developed criteria and scoring rules for evaluating proposed habitat projects. There are separate evaluation criteria for restoration, protection, assessment, design, and monitoring projects. These criteria are designed and intended for the review and scoring of proposals within the Salmon Recovery Funding Board (SRFB), Bonneville Power Administration (BPA), and other funding processes. The goal of the UCRTT is to use the most objective evaluation approach possible to ensure a fair and effective review and ranking of proposals across multiple project types. Because the proposal is the primary instrument by which the UCRTT evaluates potential projects, the clarity and completeness of the proposal is critical to the UCRTT's ability to assess and score the potential benefits of the project. The UCRTT developed evaluation criteria for both pre-proposals and full proposals. The process used to evaluate proposed projects are summarized below.

Pre-Proposal Evaluation

The UCRTT has limited capacity to evaluate a large number of full project proposals during any given funding cycle. Therefore, they set up an evaluation of pre-proposals to help filter the number of full proposals received. This early evaluation only applies when the ask from those proposed projects exceeds the funding available. This early evaluation benefits both the UCRTT and project sponsors. That is, early feedback from the UCRTT provides project sponsors information on the competitiveness of their applications and the UCRTT is not overburdened reviewing full applications that are not competitive within a funding cycle. This also directs project sponsors to spend more time and resources on developing competitive applications. Importantly, this process will only be used when the funding request across all proposed projects exceeds the SRFB funds available within a funding cycle.

The UCRTT developed a sub-set of full criteria for evaluating pre-proposals. Pre-proposals include project objectives, a brief description of the proposed project and its size (footprint), the location of the project, limiting factors addressed, costs, and landowner support. Based on this information, the UCRTT evaluates whether the proposed project is placed within an important assessment unit, addresses important limiting factors or protects high quality habitat, enhances or protects natural processes, and improves freshwater survival and/or capacity. These criteria and scoring rules are linked to the Prioritization Strategy. The criteria and scoring rules for evaluating pre-proposals are found at Pre-Proposal Evaluation Criteria.

Full Proposal Evaluation

For full project proposals, the UCRTT identified criteria and scoring rules that determine whether proposed projects are located within high-priority areas, address important limiting factors, and provide benefits to target species productivity and distribution. Various criteria form the basis for evaluating each of the five project types (restoration, protection, assessment, design, and monitoring). As with the evaluation of pre-proposals, criteria and scoring rules are linked to the Prioritization Strategy. Criteria are assigned weights depending on their importance in the overall evaluation. That is, some criteria are considered more important than others. Thus, those criteria with high weights are considered more important in the evaluation of each project type. The assignment of weights also increases contrast in scores among project proposals. Projects scoring less than 40 points out of 100 are specifically called out as having “low biological benefit” so that funders and other reviewers can determine whether the project is worth further evaluation or funding.

The UCRTT believes it is important to assess the cost effectiveness of each proposed project, even though this is largely the responsibility of other entities (e.g., the Citizens’ Advisory Committees (CACs) in the SRFB process). The UCRTT has included the evaluation of cost-benefit in various ways in the past, ranging from a qualitative evaluation that was not part of official scoring, to a quantitative assessment that applied a standardized score to each project for each reviewer. Under the current approach, each member of the UCRTT evaluates the cost effectiveness of each proposal independently. Each member decides the points for cost effectiveness by evaluating the biological benefit and cost of each project. Scores range from 0 to 7, with the highest points associated with high-benefit/low-cost projects and the lowest points associated with low-benefit/high-cost projects.

It is important that project sponsors recognize that projects scoring highest in a given funding round are those with the highest potential for addressing limiting factors and life stages within high priority areas and improving or maintaining the freshwater survival of target species relative to the other projects scored within that round. The criteria and scoring rules for evaluating full proposals are found at Full Proposal Evaluation Criteria.

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