REACH ASSESSMENT GUIDANCE FOR THE UPPER COLUMBIA

UCRTT

UPPER COLUMBIA
REGIONAL
TECHNICAL TEAM

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Definitions

Assessment Unit – A watershed used as the spatial currency in the Upper Columbia Biological Strategy's prioritization framework. The size of an assessment unit is commonly a USGS 12-digit hydrologic unit.

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.

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.

Rapid Assessment – A cursory evaluation of the current geomorphic condition of one or more valley segments within an individual stream or river. The results may provide insight into potential strategies for improving or protecting salmonid habitat.

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.

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.

Rehabilitation – One of four pathways of river management action 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.

[1] Unfortunately, restoration has been used interchangeably with enhancement, rehabilitation, mitigation, creation, and improvement. Strictly speaking, these terms do not mean the same thing.

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.

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.

Introduction

Collecting and evaluating information about freshwater and riparian habitat is an essential first step to developing a successful salmon, steelhead, or bull trout recovery project. Without assessing the current availability and restoration potential of salmonid habitat, it would be difficult to know where to focus conservation and restoration efforts. In addition, it would be difficult to identify the types of projects that would provide the most benefit to ESA-listed Upper Columbia fish populations given the finite resources that are available to complete the work. An assessment of not only the habitat but also the geomorphic processes, ecological interactions, and human history in each study area provides invaluable information to decision makers and project sponsors.

This document describes the necessary components of a reach assessment and defines its role in the implementation of the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*. Information from reach assessments is requisite for prioritizing enhancement and protection projects, as data and results from them are needed to help populate the Upper Columbia prioritization tool. Examples of finalized reach assessments can be found on the Upper Columbia Salmon Recovery Board (UCSRB) website (Assessments).

Importantly, reach assessments need to be completed in areas where no reach assessment data are currently available or where previous reach assessment data are outdated (>10 years old). Where data have been collected for Ecosystem Diagnosis and Treatment (EDT) modeling, most of the information in a reach assessment are collected as part of EDT or are outputs from EDT modeling. Thus, where EDT modeling has occurred (e.g., Okanogan and Methow River basins), reach assessments are likely not needed. Exceptions may be identification of geomorphic and hydrologic processes and locations upstream from anadromy. The EDT information can be found at:

Okanogan Habitat Status and Trends (ecosystems.azurewebsites.net)

Methow Habitat Status and Trends (ecosystems.azurewebsites.net)

Description of Reach Assessments

Fundamentally, reach assessments should provide valuable and insightful information about salmonid habitat to guide decision making about how to recover these imperiled populations. Specifically, reach assessments should identify areas where fish habitat can be protected or enhanced, as well as identify specific projects that will address the habitat factors limiting the abundance and productivity of target fish populations. Reach assessments should identify the geomorphic processes—historical, current, and future trends—that are responsible for the creation of fish habitat. Funders and project sponsors rely on reach assessments to support the identification and development of specific habitat rehabilitation or conservation actions.

Reach Assessment Spatial Framework

A spatial hierarchy of processes is responsible for stream channel and floodplain morphologies. At the broadest scale, the lithology and tectonic history of a physiographic province influences the quantity and caliber of sediment supplied to a drainage network. At the scale of a region such as the Upper Columbia, climate and topography influence sediment and water supply. The flux of water and sediment in turn creates assemblages of geomorphic units such as pools, bars, and floodplain features that are organized into patterns at the spatial scale of a geomorphic reach. Reaches are a subdivision of valley segments, which are defined by valley slope and valley confinement. From broad-scale geology to fine-scale geomorphic units, a nested spatial hierarchy of processes influence the quality and quantity of fish habitat within a watershed.

In terms of recovery, the broadest scales of the Upper Columbia River region are the Evolutionarily Significant Unit (ESU) and Distinct Population Segment (DPS) scales. Finer spatial scales include the population (or subbasin), and watershed (or assessment unit, e.g., HUC 12).

An assessment of physical habitat should incorporate an evaluation of processes operating across a range of spatial scales from a geologic province to 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.

To the extent possible, the analysis framework for Upper Columbia reach assessments should incorporate the spatial units used in the Upper Columbia River prioritization strategy (Prioritization Strategy). The finest scales are the assessment unit and the geomorphic reach. Reach assessment boundaries and spatial units should be consistent with this common framework whenever possible.

GIS spatial layers for the region's spatial framework can be found on the UCSRB's web portal. Specifically, a flowline network containing geomorphic reaches can be found here, Reaches, under the name "Reaches and Reach Breaks." A map showing the spatial framework can also be found by clicking the link under the "Webmaps and Applications" tab.

Tools and Data Sources

Many different tools are available to assist with the development and implementation of a reach assessment. Tool and method selection should be based on the following:

- Data availability
- Tool accuracy and precision
- Level of effort required to execute the tool
- Ability of the tool to achieve the objectives

- Trust and confidence in the tool based on its application in previous studies
- Experience and analytical skill of the researcher
- Amount of time and funding allocated to complete the assessment

A reach assessment will likely use both qualitative and quantitative tools. Examples of qualitative tools include literature reviews, interviews with local experts and residents, repeat ground photography, and interpretation of existing data such as geologic maps, land survey maps, and reports. Examples of quantitative tools include hydraulic models, habitat suitability models, stream habitat surveys, statistical analyses, remote sensing analyses (e.g., aerial photograph, photogrammetry, etc.), topographic surveys, geomorphic surface mapping, and geochronologic dating tools. Kondolf and Piegay (2016) provide a comprehensive review of several tools that are available to researchers.

Reach Assessment Components

In general, a reach assessment should evaluate the historical, current, and potential future condition of stream and riparian habitat, and the spatial hierarchy of processes that influence the geomorphology of the study area. At the broadest scale, a reach assessment should describe, and, if possible, quantify the processes that influence the supply of water and sediment in the assessment unit. This can be accomplished by summarizing the geology, climate, topography, and vegetation of the valley segments in the study area as well as the contributing watershed.

At a finer scale, a reach assessment should describe the processes that are responsible for the morphology of the valley segment(s) and the geomorphic reaches contained within them. At the finest scale, the reach assessment should describe and quantify to the degree possible the various characteristics of the stream channel and floodplain that may adjust to changes in sediment supply and water discharge. These modes of adjustment, or degrees of freedom, include channel geometry, bed configuration, planform, and slope. In addition to an evaluation of geomorphic attributes, the reach assessment should include an evaluation of the hydraulics and the specific ecologic features and processes that influence salmonid habitat.

In order to properly evaluate freshwater salmonid habitat conditions, it is critical to document the impairments in the study area. For example, since the beginning of Euro-American settlement in the late 1880s, numerous anthropogenic actions have negatively affected salmonid habitat in the Upper Columbia. Humans have built roads for logging across large swaths of the landscape, built highways and railroads in floodplains and across rivers, harvested timber nearly everywhere including the valley bottoms, used rivers to transport logs, removed large woody debris in rivers for flood control, developed floodplains for agriculture, built levees to protect infrastructure, and installed riprap along banks to reduce erosion. These actions severely impaired the quality and quantity of salmonid habitat. Therefore, it is essential to describe and map these impairments and discuss their effects on geomorphic processes and salmonid habitat condition.

Another key component of a reach assessment is the reconstruction of the history of each river reach or valley segment. There are many qualitative and quantitative data sets and tools available that can be used to do this. For an explanation of why an historical reconstruction is important to fish habitat restoration, please refer to Kondolf and Larson (1995).

Importantly, reach assessments need to evaluate fish periodicity and habitat use within the reach. The timing and preferences of different species directly relate to the identification of potential actions. At a minimum, the assessment should document species and life stages present, timing of reach use, relative abundance/importance, as well as any other biological aspects of note.

In some cases, a reach assessment may be conducted to update past assessment data and findings because they no longer represent current conditions. In this instance, completing all components of a full reach assessment may not be needed and a “rapid assessment” approach can be used. Furthermore, reach assessments in smaller streams may warrant a more refined data collection effort and a more concise write-up, partially because of the lack of funding and data available in these areas. That said, a “rapid” assessment should not be used in place of a full reach assessment except in certain cases. Project sponsors and funders are encouraged to work with the UCRTT to determine when and how to use a rapid assessment in lieu of a full reach assessment.

Because the desired outcome is a robust and cost-effective reach assessment, researchers proposing or conducting one should closely coordinate their efforts with those of other entities and individuals working in the region and with the UCRTT. This will help prevent the duplication of effort and data and ensure that appropriate reach assessment methods and protocols are being used. Furthermore, researchers should coordinate closely with federal, state, regional, tribal, and local organizations as well as private landowners. To improve coordination, researchers are encouraged to collaborate with the Watershed Action Teams, Methow Restoration Council, and Implementation Team as appropriate.

A reach assessment report should follow the standard structure of a scientific publication. Following an introduction, the report should state the purpose of the study, describe the methods, present the results, and discuss and interpret finding. Finally, the report should use the sound scientific evidence that is acquired during the assessment to propose a practical and useful restoration strategy. What follows is a description of the components that should be included a reach assessment.

Introduction and Background

The Introduction and Background provide justification for the reach assessment and describe how it is related to the recovery of ESA-listed fish species in the region. It also describes the goals, objectives, and location of the assessment.

Methods

This section describes the analytical methods and any other methods used. It is important to present methods to provide transparency, repeatability, and confidence in the reach assessment results.

Study Area Characteristics

Pertinent valley segment and watershed characteristics, especially those that influence the geomorphic and habitat conditions in the study area, are described in this section. A list of recommended data that are used to evaluate and summarize the study area and the surrounding watershed is provided below:

1. Hydrography
2. Geography
3. Physiography (i.e., Ecoregion)
4. Geology
5. Hydrology
6. Climate including predicted future changes
7. Vegetation
8. Natural disturbances (e.g., wildfire, mass wasting, etc.)
9. Land use including human history and disturbance
10. Fish use

Assessment Results

Stream Habitat

It is necessary to conduct a field-based evaluation of existing stream and riparian habitat in the study area. The field evaluation should include the measurement of select habitat attributes important to fish including large wood, riparian structure, bed material, and locations and dimensions of channel units such as riffles, pools, glides, bars, and floodplains. To ensure alignment with the existing regional habitat datasets, existing habitat condition measurements should be performed using protocols found in the USFS Level II Stream Inventory Handbook (USFS 2016). Researchers should consider conducting spatially explicit fish habitat modeling (e.g., habitat suitability index modeling) to quantify fish habitat suitability in the study area.

Sediment Transport

Because bed material is influenced by the flux of both water and sediment, and constitutes the physical template of fish habitat, it is important to evaluate bed material size distribution in the study area. This analysis is an important component of an evaluation of the quantity and quality of fish habitat. Furthermore, an evaluation of bed material can be used to determine the sensitivity of the study area to geomorphic changes, which will lead to a better understanding of geomorphic recovery potential. Bed material analyses should focus on areas of the channel and floodplain that are composed of different sediment facies (i.e., areas of similar grain size distributions). Interpretation of bed material data may also provide insight into sediment transport dynamics including supply, storage, and evacuation. An example of bed material analysis includes incipient motion. Additionally, an evaluation of suspended load should be made, if relevant to the study area.

Hydraulics

It is necessary to complete an analysis of the hydraulics of the study area. If available funding and data allow, development a 1-dimensional or 2-dimensional hydraulic model for each reach is suggested. The hydraulic model should represent current conditions and, if possible, potential conditions at multiple stream flows (e.g., base flow, 2-yr, 10-yr, and 100-yr recurrence interval flows). Hydraulic modeling should be conducted at the reach scale. The hydraulic model results that should be included are maps of inundation extent, water depth, and water velocity.

Geomorphology

Geomorphic Organization of the Study Area

It is important to describe the geomorphic organization of the alluvial valley with a focus on the channel(s) and floodplain. This section should include geomorphic mapping of the alluvial surfaces within the valley, construction of a longitudinal profile, and the delineation and classification of geomorphic reaches and valley segments.

Alluvial valley geomorphic surface mapping

Describe each type of geomorphic surface that occurs in the study area by its sedimentology, height above water surface, position in the valley, topographic expression, and vegetation community. Examples of geomorphic surfaces include active channel, floodplains, terraces, and alluvial fans. Additionally, the perimeter of the valley bottom, which is that portion of the valley that is comprised of the active channel(s) and the floodplain should be mapped.

Longitudinal Profile

Create a longitudinal profile of the study area. If the study area is small, consider extending the longitudinal profile in both the upstream and downstream directions of the study area. A longitudinal profile is useful for evaluating sediment transport capacity. Features to highlight include changes in slope, the shape of the profile, knickpoints, and tributary influences.

Valley Segment and Reach Delineation

Delineate and classify both the valley segments and geomorphic reaches in the study area. Classify valley segments using valley confinement and slope or stream power. Classify and describe each geomorphic reach using the following geomorphic characteristics: valley confinement, bed material size, channel geometry, organization of geomorphic units (including both channel and floodplain), and slope or stream power.

Historical Geomorphic Evaluation

It is also important to evaluate the geomorphic characteristics of the study area during the historical time period. At a minimum, describe the historical geomorphic characteristics using available information such as interviews with residents, repeat ground photography, and other historical information such as General Land Office survey maps and notes. Preferably, the study will quantify geomorphic changes and calculate rates of changes. Together with an evaluation of stream flow changes, an understanding of geomorphic changes can be used to determine the mechanisms that are responsible for the present character and condition of fish habitat.

Numerous methods are available for quantifying geomorphic changes. For example, one of the most powerful methods for quantifying geomorphic changes, specifically planform changes, is to interpret a time series of aerial imagery and measure channel migration rates. Additional methods may be used to quantify geomorphic changes (e.g., quantifying floodplain development using geochronology tools). The types of change analyses that are chosen should be dictated, in part, by the character of the study area, data availability, resources that are available to complete the study, and the questions that need to be answered.

Existing Geomorphic Evaluation

It is necessary to summarize the information that was generated in the previous sections, specifically fish habitat, sediment transport, hydraulics, and geomorphology sections to describe the current geomorphic condition of each reach. The summary should include a description of the anthropogenic impacts to the reach and how these impacts have affected the geomorphic condition. Delineated reaches and valley segments should be presented as maps in the final report. Locations of anthropogenic impacts should also be included in these maps.

Ecology

Researchers should discuss which fish species and life stages reside in the study area and when they reside there (periodicity), and describe the habitat features that support them. If data are available, this section should describe the ecological characteristics of the study area that influence the distribution, abundance, and productivity of the various life stages of each fish species. Important ecological characteristics to address include stream temperature, other water quality parameters (e.g., dissolved oxygen, contaminants, etc.), food web dynamics, and invasive species interactions. Data sets that may be useful to analyze and summarize include redd survey data, outmigrant trap data, juvenile survey data (e.g., PIT tag or snorkel data), and water quality data.

Discussion

This section should interpret results and shows how salmonid habitat has changed over time, which fluvial processes are responsible for the current habitat condition, which fluvial processes were responsible for the historical habitat condition, and what factors are responsible for changes that may have occurred to habitat forming processes. In addition, this section should speculate on the future trends in habitat quantity and quality based on the insights that have been acquired regarding the habitat-forming fluvial processes occurring in the study area. The discussion should include a description of the factors that are currently limiting the production and survival of fish populations in the study area.

Restoration Strategy

The Restoration Strategy is a critical component of each reach assessment. Importantly, this section outlines how to enhance or conserve salmonid habitat in the study area. A "restoration strategy" should do the following:

1. Develop a reach-based ecosystem indicators matrix (REI). This is a comparison of current habitat conditions to established functional thresholds. Habitat data should be qualitatively classified (reported as Acceptable, At Risk, or Unacceptable) through the use of Reach Ecosystem Indicators (click here for Upper Wenatchee Reach Assessment example).
2. Identify the target habitat conditions. In addition to the insights gained from the assessment, the REI scores and the *Upper Columbia Biological Strategy* may be useful in identifying appropriate target conditions.
3. Identify projects that will either improve or protect fish habitat. Include the specific action type as well as the specific location of the project (i.e., reach and river mile). Estimate the biological benefit of each action type; for example, identify the life stages that will benefit from the project and/or the limiting factors that will be addressed by the project.

Review, Distribution, and Use of Reach Assessment

Once data collection and a draft report of the reach assessment are completed, the UCRTT will review it for completeness and accuracy. This review will focus primarily on whether the reach assessment comports with the Biological Strategy and the Prioritization Tool, whether it is complete, and what changes may be warranted. Prior to the UCRTT review, it is recommended that the authors of the assessment (i.e., the assessment sponsor and, if applicable, the consultant) present on it to the UCRTT. The UCRTT will provide the sponsor with a list of comments, some of which may require a response and a revision of the report. In rare instances, the review may warrant additional analyses and interpretation as well as a significant revision of the report. Upon completion of the comment-response process, the sponsor will receive a letter from the UCRTT acknowledging the sufficiency of the reach assessment.

Once finalized, reach assessments will be made available to regional sponsors and stakeholders for use in project prioritization and development. The UCSRB compiles reach assessments and makes them available on their website through this link: Assessments. Implementors are strongly encouraged to post their completed reach assessment in this public library, so that it can be used by project sponsors, partners, and the UCRTT. Data and GIS layers are also important to make available and should be submitted to UCSRB and the UCRTT for use and distribution (as appropriate).

Use in Prioritization

The Upper Columbia prioritization strategy relies heavily on the data that are collected for and compiled in reach assessments. These data are used to 1) prioritize assessment units; 2) evaluate habitat quality; 3) identify potential limiting factors; and 4) identify important fish passage barriers. The UCSRB and UCRTT are responsible for inputting relevant raw data and REI indicator values into the UCRTT's Prioritization Tool. Projects, including their assigned priority, that are identified in reach assessments are also compiled and tracked by the UCSRB for use by the UCRTT, sponsors, and partners. Implementers are encouraged to work with UCSRB staff to ensure all available data are input into these important prioritization products.

References

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