Lower Columbia Fish Recovery Board

Tidal Literature Review and Recommendations

Background

The Lower Columbia Fish Recovery Board (LCFRB) receives applications every year for habitat restoration projects through its administration of Salmon Recovery Funding Board (SRFB) grants, funded by Pacific Coastal Salmon Recovery Fund and Washington State dollars. The LCFRB and its Technical Advisory Committee (TAC) score projects based on expected Benefits to Fish, Certainty of Success, and Cost (see the LCFRB Evaluation Criteria for more details). Benefits to Fish are based in part on Ecosystem Diagnosis and Treatment (EDT) derived Species Reach Potential (SRP) ratings, which reflect both population priority, and contribution of a stream reach to population performance (Table 1, Table 2, and Table 3). SRP ratings are considered, along with population classifications and reach tiers, to determine the Population/Reach scores and ratings for a project.

Table 1. Species Reach Potential (SRP) ratings based on EDT-derived population-scale performance metrics. Population performance is calculated by summing EDT-modeled population abundance, productivity, and diversity responses to degradation and full restoration of habitat within an EDT stream reach. Full restoration is defined as restoring current habitat conditions (patient) to historical conditions (template). Degradation is defined as reductions to current habitat conditions.

SRP Rating	Description
High	Habitat (at the EDT-reach scale) supports the top 30% of population performance (abundance, productivity and diversity) within the subbasin.
Medium	Habitat (at the EDT-reach scale) supports the second 30% of population performance (abundance, productivity and diversity) within the subbasin.
Low	Habitat (at the EDT-reach scale) supports the bottom 30% of population performance (abundance, productivity and diversity) within the subbasin.

Table 2. Population recovery classifications. Persistence probability is for a 100-year period.

Population Classification	Viability Goal	Description	Persistence Probability
Primary (P)	High (H) or High+ (H+)	Low (negligible) risk of extinction (represents a "viable" level)	95 – 99%
Contributing (C)	Medium (M)	Medium risk of extinction	75 – 94%
Stabilizing (S)	Low (L)	Stable, but relatively high risk of extinction	40 – 74%

Table 3. Tier rating definitions for the Lower Columbia River region.

Reach Designation	Criteria
Tier 1	All high priority reaches (based on EDT) for one or more primary populations
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary populations and/or all high priority reaches for one or more contributing populations
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

The majority of projects are proposed to be implemented in tributary habitat, where EDT modeling was used to determine Population/Reach ratings and scores. However, the LCFRB also receives some applications for projects in tidally influenced areas, which include the Lower Columbia River estuary (the Columbia River mainstem from Bonneville Dam through the estuary plume), as well as tributary habitat affected by tidal fluctuations[1] (Figure 1). EDT modeling was not conducted for tidally-influenced habitats, or excluded tidal habitat parameters for tributaries, so there is no EDT-based standard for determining SRP ratings for project evaluation. Instead, the 2016 version of the LCFRB evaluation criteria states the following:

"Given the absence of comprehensive EDT modeling results for estuary mainstem and tidally influenced tributary reaches, staff will develop draft species reach potential ratings and rationale for TAC review." (page 10)

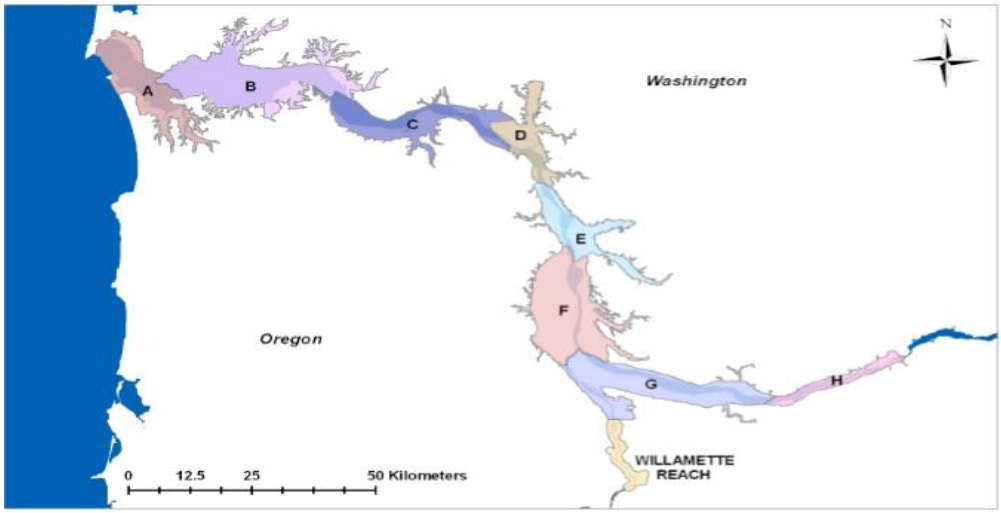

Figure 1. Lower Columbia River estuary reaches and extent of tidal influence, level 3 hydrogeomorphic reaches (Reprinted from the Estuary Module 2009, available at: http://www.estuarypartnership.org/columbia-river-estuary-ecosystem-classification#CREEC Level 3.)

[1] To view extent of tidally-influenced habitat, use the Lower Columbia Estuary Partnership Restoration Prioritization Strategy interactive map.

It was standard practice prior to 2016 to assign SRP ratings of Medium and a Tier 2 designation to estuary projects, although SRPs were assigned on a case-by-case basis. In 2016, staff recommended assigning a "High" SRP rating to an estuary project because: 1) there was a lack of suitable rearing habitat in the estuary reach due to seven miles of armored shoreline with limited off-channel connections; and, 2) connectivity of the project to other nearby estuary restoration efforts[2]. To help standardize assignment of SRP ratings, staff formed a TAC sub-committee in the Fall of 2016 to:

1. Collect and discuss literature related to salmonid use of tidally influenced habitat in the Columbia River;
2. Based on the literature, identify restoration approaches that are appropriate for use in the estuary;
3. Provide supporting references and rationales for SRP recommendations; and,
4. Suggest a standard approach for SRP ratings for restoration and protection projects in the estuary and tidally-influenced habitats.

This document includes deliverables and discussion points related to objectives one, three, and four. However, SRP recommendations and rationales should evolve as new information is gleaned regarding salmonid-habitat relationships in tidally influenced areas.

Objective 1: Collect and discuss literature related to salmonid use of tidally influenced habitat

Two meetings were held to discuss relevant literature on salmonid use of tidally influenced habitat in the Lower Columbia River, and to develop a standard SRP rating system and rationale. Committee members provided electronic copies of pertinent technical and reference documents, and the LCFRB centralized the information in a web-based Dropbox folder for working purposes of the committee.[3]

Objective 2: Identify restoration approaches that are appropriate for use in the estuary

This objective has not yet been completed.

Objective 3: Provide supporting references and rationales for SRP recommendations

The TAC sub-committee and LCFRB staff used literature collected under Objective 1 to inform discussions and to support rationales for SRP recommendations found under Objective 4. Below are the collected resources that are referenced in this document:

1. Bottom, D.L., Jones, K.K., Cornwell, T.J., Gray, A. and Simenstad, C.A., 2005a. Patterns of Chinook salmon migration and residency in the Salmon River estuary (Oregon). *Estuarine, Coastal and Shelf Science*, *64*(1), pp.79-93.
2. Bottom, D.L., Simenstad, C.A., Burke, J., Baptista, A.M., Jay, D.A., Jone, K.K., Casillas, E. and Schiewe, M.H., 2005b. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-68, pp. 1 – 246.
3. Craig, B.E., Simenstad, C.A. and Bottom, D.L., 2014. Rearing in natural and recovering tidal wetlands enhances growth and life-history diversity of Columbia Estuary tributary coho salmon Oncorhynchus kisutch population. *Journal of Fish Biology*, *85*(1), pp.31-51.

[2] Project number 16-1524, Columbia-Pacific Passage, Hungry Harbor Design: staff scoring assumptions.
[3] Contact the LCFRB for access to the "Estuary Literature" files.

4. Lower Columbia Estuary Partnership, 2012. A Guide to the Lower Columbia River Ecosystem Restoration Program, Second Technical Review Draft. Prepared by the Lower Columbia Estuary Partnership, Portland, OR, December 14, 2012, pp. i – 172.
5. McNatt, R.A., Bottom, D.L. and Hinton, S.A., 2016. Residency and Movement of Juvenile Chinook Salmon at Multiple Spatial Scales in a Tidal Marsh of the Columbia River Estuary. *Transactions of the American Fisheries Society*, *145*(4), pp.774-785.
6. National Marine Fisheries Service, 2011. Columbia River estuary ESA recovery plan module for salmon and steelhead. Prepared by the Lower Columbia River Estuary Partnership and PC Trask and Associates, Inc. pp. i – 260.
7. Roegner, G.C., McNatt, R., Teel, D.J. and Bottom, D.L., 2012. Distribution, size, and origin of juvenile Chinook salmon in shallow-water habitats of the lower Columbia River and estuary, 2002–2007. *Marine and Coastal Fisheries*, *4*(1), pp.450-472.
8. Sather, N.K., Johnson, G.E., Teel, D.J., Storch, A.J., Skalski, J.R. and Cullinan, V.I., 2016. Shallow Tidal Freshwater Habitats of the Columbia River: Spatial and Temporal Variability of Fish Communities and Density, Size, and Genetic Stock Composition of Juvenile Chinook Salmon. *Transactions of the American Fisheries Society*, *145*(4), pp.734-753.
9. Simenstad, C.A., Burke, J.L., O'Connor, J.E., Cannon, C., Heatwole, D.W., Ramirez, M.F., Waite, I.R., Counihan, T.D. and Jones, K.L. 2011. Columbia River estuary ecosystem classification—concept and application. US Geological Survey, No. 2011-1228, pp i – 54.
10. Simenstad, C.A., Ramirez, M., Wagoner, H.M., Whiting, A.H., Trask, P.C. 2014. A Landscape Approach to Planning Restoration and Conservation of Anadromous Fish Habitat across a Complex Estuarine Mosaic: Applications to Long-Term Monitoring and Salmon Recovery. *Proceedings 9th European Conference on Ecological Restoration*, pp. 1 – 4.

Objective 4: Suggest SRP ratings for restoration of tidally influenced habitat types

The committee discussed Species Reach Potential (SRP) rating recommendations for local populations (in-basin) in tidally-influenced habitat as well as out-of-basin populations (OOB). OOB populations are defined as those with individuals from non-natal subbasin populations in the Lower Columbia Evolutionary Significant Units (ESUs) and Distinct Population Segments (DPS), as well as those from areas upstream of the Lower Columbia ESUs and DPSs. The decision to include both in-basin and OOB populations was reached based on recent studies in the Lower Columbia that determined multiple species of juvenile salmonids from stream and ocean-type populations utilize tidally-influenced habitat in the Lower Columbia (Sather et al. 2016). Although OOB populations are generalized in this definition, project sponsors are encouraged to present available data demonstrating fish use of target habitats within the project area. Fine-scale understanding of habitat use could improve the basis for assigning recovery benefits to restoration activities.

All anadromous salmonid populations in the Columbia River rely on estuarine and tidally influenced habitat, migrating through on their way to and from the ocean at a minimum. Many species also rear in tidal environments for more extended periods, and gain additional benefits from high quality shallow water habitats. For instance, Chinook are known to rear in tidal habitats from fry (< 60 mm) through yearling (>100 mm) life stages, and chum rear beginning as fry (<50 mm) (NMFS 2011). Recent tidal studies have observed year-round (Chinook and coho salmon), winter and spring (chum salmon), and fall and spring (steelhead) salmonid presence, although all species except for chum were most abundant in

the spring (Sather et al. 2016). Coho salmon fry (< 60 mm), parr (60 - 100 mm) and yearlings (>100mm) from the Grays River system have been observed in tidal wetland habitat from spring through summer, suggesting diverse life history patterns are associated with tidal wetland habitat availability (Craig et al. 2014).

SRP ratings should reflect the importance of ecological functions provided by habitat targeted for restoration or protection to overall population performance of a species. At a coarse-scale, it is important to maintain and restore a diversity of tidally-influenced shallow water habitats because of the rearing and life history diversity benefits they provide to salmonids (Sather et al. 2016, Craig et al. 2014, Bottom et al. 2005a) as well as the disproportionate loss of shallow water rearing habitat in the Columbia River estuary (Bottom et al. 2005b). At a more fine-scale, there are seasonal and diurnal variations in tidally-influenced shallow water habitat accessibility and quality across habitat types (Sather et al. 2016, McNatt et al. 2016). For instance, shallow tidal freshwater habitats provide important foraging and refuge opportunities for juvenile salmonids, although higher salinity tidal habitats may also support osmoregulatory transitioning for smoltification (Roegner et al. 2012). SRP ratings should reflect the importance of this variation and diversity, and the overarching high importance of tidally-influenced shallow water habitat to population resiliency and long-term viability.

It is recommended that sponsors, LCFRB staff, and TAC consider recent estuary literature and habitat mapping when determining whether coarse and fine-scale restoration objectives are adequately addressed. The following resources are geospatial tools that can help evaluate the coarse (landscape) and fine (habitat patch) scale benefits from a project:

- The Columbia River Estuary Ecosystem Classification encompasses all tidal habitat, including historical tidal floodplains in the Columbia River, based on geomorphic and ecological factors defined at six hierarchical scales (Simenstad et al. 2011). Defining habitat types that are important to all rearing and migrating salmonid species, and querying this information from the Columbia River Estuary Ecosystem Classification, could increase the diversity of habitat types to consider for restoration.
- The Landscape Planning Framework (LPF) classifies tidally-influenced habitat types based on juvenile Chinook salmon rearing benefits (fish habitat catena) (Simenstad et al. 2014). Fish habitat catena data can be used to quantify area, distance, and connectivity of specific estuarine habitat patches at multiple spatial scales. Furthermore, the relative availability of different habitat types can be determined by calculating the proportion of open (accessible fish habitat catena) to altered (regulated or isolated fish habitat catena), which in turn can be used to estimate the percent change expected from restoring a specific altered habitat area (Simenstad et al. 2014). Data was queried from the Columbia River Estuary Ecosystem Classification.
- The Restoration Prioritization Strategy developed by the Lower Columbia Estuary Partnership includes a Habitat Suitability Index (HSI) model for juvenile Chinook salmon, based on water temperature, depth, and velocity criteria. The HSI can be used to determine the proximity of proposed work to suitable tidal habitat under multiple flow year scenarios.

Based on a review of available literature, the sub-committee recommends that all projects proposed within tidally-influenced habitat are assigned a default baseline SRP rating of High for in-basin and out-

of-basin populations because of the important foraging and refuge benefits these habitats provide to fry, parr, and smolts, and the life history diversity benefits they provide to support species resiliency.

Tidally-influenced habitat restoration projects can be assigned a lower SRP rating (Medium or Low) if the TAC determines that habitat benefits are not optimal or are low priority for recovery. Staff and TAC will use the following questions to help determine whether the default High rating should be changed to a Low or Medium SRP rating:

- Does the project include restoration, enhancement, or creation of historically important habitat types (e.g. tidal flats, emergent and forested tidal wetlands, and sloughs)?
- Does the project preserve, increase, or enhance cold water refuge opportunities?
- Are there overriding concerns regarding water quality that could reduce realized project benefits?
- Does the project support high quality foraging opportunities, with macro-detrital inputs considered optimal?
- Is there a high degree of connectivity between the targeted habitat and the mainstem Columbia?
- Is the seasonality of habitat availability and accessibility aligned with peak juvenile salmonid presence (January – July)?
- Do spatial location and restoration objectives add complexity to the tidal habitat landscape, to support restoration of historically complex and diverse tidal conditions?
- Has the applicant provided other site-specific fish use and habitat information to substantiate ratings?