ERTG Uncertainties

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Prepared in Response to: Work Request #2012-02 from the ERTG Steering Committee (3/20/12)

Work Request #2012-02: The Action Agencies implementing the Columbia Estuary Ecosystem Restoration Program (CEERP) desire to make well-informed decisions on project actions and RME. There are, however, uncertainties in the CEERP knowledge base. Uncertainties related to ERTG scoring criteria (ERTG Doc #2010-02) are particularly important because they affect the risk the Action Agencies must contend with when deciding on project funding. Understanding the ERTG's opinions about key uncertainties will help the Action Agencies prioritize research, monitoring, and evaluation efforts. Therefore, the Steering Committee requests that the ERTG list the key uncertainties and rationale for each that the ERTG faces when scoring prospective restoration projects.

Work Product #2012-02

The following summaries of scientific uncertainties, associated with salmon recovery and habitat restoration in the lower Columbia River and estuary, are accompanied by lists of more detailed associated questions and hypotheses whose resolution would reduce some of the uncertainties. The summaries are ordered from small to large scale.

Large Woody Debris

What is the ecological role of LWD in [a] tidal marshes, [b] river floodplains, [c] floodplain lakes and ponds?

There is a significant literature on the ecological and geomorphological role of LWD in river channels, probably a limited literature on LWD in floodplains (aside from nurse log function and denning sites for wildlife), and a nearly non-existent literature on historical amount and function of LWD in tidal wetlands.

Higher resolution questions include:

--Does LWD provide cover/shelter/rearing areas for juvenile salmon?

--Does LWD increase juvenile salmon residence time in tidal channels or floodplain ponds/lakes?

--Does LWD provide ambush sites for bass and other predators on salmon?

--Is there spatial variation in the ecological role of LWD (e.g., depending on riverine/estuarine/lacustrine character, water depth, velocity, vegetation cover along banks, etc.), i.e., how does wood function in different wetland types and locales along the tidal gradient; does LWD function similarly for salmon in a forested slough with little tidal exchange as it does in an emergent wetland that drains twice daily with each tide?

--Does LWD have a geomorphological role in tidal channels, e.g., provide scour holes that are occupied by juvenile salmon?

-- Is LWD a transitory/moveable habitat structure; if placed, should it be allowed to float away?

--Does the orientation of large wood pieces relative to tidal currents influence the potential function of LWD as salmon habitat?

Pilings

What is the ecological role and impact of pilings on salmon? Do they need to be removed?

There is some interest in removing pilings as a restoration action, but it is unclear what their impacts are on geomorphology/hydrology, salmon migration, rearing or predators.

Higher resolution questions include:

--Are creosote, heavy metals, or other pollutants leaching from the pilings? While leaching pollutants have been documented in some situations, very old pilings have sometimes been shown to have no pollutants left to leach. Which types of pilings are sources of leaching pollutants and which types are not?

--Do pilings have geomorphological effects which are significant to salmon habitat or migration pathways?

--Do pilings affect salmon migration behavior as they move along channel margins?

--Do pilings provide shelter for juvenile salmon in a manner analogous to that hypothesized for LWD?

--Do pilings provide significant ambush sites for salmon predators like bass or diving birds?

--How do different piling "types" influence salmon behavior or performance, (e.g., transverse pilings across wetland channels vs. spur dikes built perpendicular to shore near the main channel vs. large piling "fields" built for log storage, docks, or other structures)?

Tidal Wetlands

How do tidal wetlands respond to different types of restoration actions?

A wide variety of actions (e.g., culvert replacement, number of dike breaches, self-regulating tide gates, channel creation) are being taken to restore tidal wetlands and their functions for salmon, but there is considerable uncertainty associated with the degree to which hypothesized site responses to restoration actions match the actual responses.

Higher resolution questions include:

--What is the value of additional dike breaches when there are already pre-existing dike breaches? Similarly, how do recovery rates, salmon access, sedimentation rates, etc. for different wetland types vary under different dike removal scenarios (i.e., full dike removal, partial removal, full spanning culvert, etc.)

--How well do constructed/created habitats benefit juvenile salmon? Do constructed /created habitats provide similar benefits as analogous natural habitats in the Columbia River estuary?

--What conditions or constraints determine the trajectories of created wetlands?

--What are the issues regarding juvenile salmon passage through culverts and tide gates under roads, tracks, levees, dikes, and other obstructions between restored off-channel sites and the river main stem

--What are the relative benefits of marsh channels and the associated marsh plain to salmon? This question arises when self-regulating tide gates are used to provide channel access to juvenile salmon while preventing adjacent plains from flooding and reverting to tidal marsh. How do tidal channels function ecologically, hydrologically, and geomorphologically when the channels are disassociated from their tidal plains?

Floodplain Lakes and Ponds

What is the role of floodplain lakes/ponds relative to juvenile salmon?

Historically there was substantially more access to floodplain lakes and ponds, but we know very little about their function for juvenile salmon or whether we can restore their historical functions in the presence of non-native warm water fishes, pollutants and water quality issues.

Higher resolution questions include:

--How do juvenile salmon use lakes and ponds?

- What is the importance of edge habitat adjacent to lacustrine wetlands?
- What is the importance of edge habitat adjacent to uplands?
- Do juvenile salmon move into different vegetated edges, e.g., submerged aquatic vegetation, emergent aquatic vegetation, over-hanging or partially submerged shrubs?
- Does the value of pelagic habitat vary depending on pond/lake depth?
- What are typical juvenile salmon densities, residence times, growth rates, and diets in floodplain lakes and ponds? Do they vary with pond/lake size?

--How do predators use ponds and lakes (bass, diving birds, wading birds)? (See above points regarding salmon use of lakes and ponds)?

--Is predation risk in ponds and lakes significant for juvenile salmon?

--Are lakes and ponds too warm for juvenile salmon during their seaward migration?

--Are there hyporheic interactions between the river and floodplain lakes and ponds that affect lake/pond temperature or water chemistry (nutrients) and plankton productivity?

--Is the productivity of salmonids in floodplain lakes/ponds related to lake/pond size? When is a floodplain lake/pond too large or too small to provide significant benefit to rearing juvenile salmon due to size-associated temperature constraints, prey availability, edge effects, or predator access/hunting efficiency?

--How does location/distance from the main river channel or from salmon source populations influence salmon use or accessibility of floodplain lakes?

--How does flow regulation influence salmon access to floodplain lakes?

Floodplains

What is the role of seasonal floodplains in the upper estuary for juvenile salmon during floods?

Historically there was substantially more access to seasonally-inundated floodplain habitats, but we know very little about their function for juvenile salmon, and whether we can restore their historical functions because of modern flow regulation and invasion by non-native warm water fishes.

Higher resolution questions include:

--How do juvenile salmon use floodplains during floods?

- How do juvenile salmon density, residence time, growth rates, and diet vary in floodplains relative to:
  - -vegetation type (meadows, shrub thickets, forests, lakes and ponds)
  - -water depth
  - -turbidity
  - -flood flow velocity
- Is stranding a common problem; is stranding related to particular types of floodplain topography?

--How do predators of juvenile salmon (e.g., bass, diving birds, wading birds) use flooded floodplains? (see above points regarding salmon use of flooded floodplains)

-- Is predation risk significant for juvenile salmon on flooded floodplains?

-- Is there an optimal amount of time for juvenile salmon to have access to the marsh surface?

--How does pulsed floodplain inundation affect organic matter and insect prey transport into the estuary?

Riparian Habitats

What are the functions of riparian vegetation for juvenile salmon along channel margins?

There is uncertainty about juvenile salmon use depending on water level and vegetation type.

Higher resolution questions include:

--What is the direct use of riparian habitats by juvenile salmon during floods?

--Do fish penetrate and shelter in flooded riparian vegetation? If so, how does fish density, residence time, diet vary depending on vegetation type—fringing emergent wetland, upland meadow, shrub, forest?

--What is the indirect use of riparian habitats by juvenile salmon during normal flow?

--How do different riparian vegetation types (fringing emergent wetland, upland meadow, shrub, forest, reed canarygrass, blackberries, Scots broome) influence adjacent water temperature, allochthonous detritus supply or detrital quality, supply of terrestrial insects, fish diets (stomach analysis and/or stable isotope analysis)?

--What are the effects of aquatic invasive species on food webs supporting juvenile salmon?

Modeling

We need quantitative predictions of channel geometry, vegetation assemblages and salmon use and productivity (e.g., survival, growth) for restoration actions in order to develop design and planning tools, and advance restoration science through monitoring and testing of the predictions.

Higher resolution questions include:

--Can we develop empirical models of tidal channel geometry for the lower estuary similar to those available for San Francisco Bay and the Skagit Delta?

--We need predictive vegetation models (currently in development by PNNL, using water level data being developed by David Jay).

--What elevations, relative to MLLW, are necessary for salt marshes and freshwater wetlands to recover at a restoration site; i.e. when does a dike breach site "recover" to a mudflat?

-- Is there an accepted average accretion rate for wetlands?

--What are the expected trajectories of restoration sites with different plant communities and tidal ranges, e.g., time to reasonable functional equivalency with natural wetlands in the LCRE?

Landscape Structure

Does the spatial organization of restoration projects have non-linear effects (e.g., amounts, synergies, thresholds, cumulative effects) on salmon use, survival, production, and life history diversity for stocks using those areas?

There is little information regarding how various projects 'work together' to provide cumulative benefit to salmon populations. Available restoration information is at the site-specific scale, projects are implemented in isolation from other projects, SBU's are calculated at the site level, and action effectiveness is evaluated at site scale. We need to be able to plan and evaluate projects relative to salmon population or ESU level response.

Higher resolution questions include:

--Do restoration projects within a particular location (e.g., Sandy River delta or other tributary junctions, Grays River tidal floodplains, Young's Bay, Multnomah Channel region, or other river habitat nodes) have a detectable effect on salmon use, survival, production, and life history diversity of stocks using those areas?

--Could an Intensively Monitored Watershed approach be useful for evaluating restoration benefits at the scale of river nodes?

--Can we detect increases in genetic/stock diversity with increasing amounts of restoration within an intensively monitored region?

--Can we detect non-linear (synergistic) cumulative effects of restoration within an intensively monitored region?

--What are the trends over time in landscape estimates of juvenile salmon density as related to multiple collective restoration actions?

--Do we need to evaluate salmon recovery at the stock/watershed scale rather than the scale of the whole Columbia River and therefore target restoration to locations that are most likely to benefit stocks in greatest need?

--Does increased landscape-scale connectivity among habitats improve salmon growth and survival?

Hatchery Salmon

How do hatchery-produced stocks affect the benefit of estuary restoration projects to natural stocks?

We need to know whether large-scale hatchery programs that primarily produce salmon with riverine life histories are compatible with the recovery of diverse salmon phenotypes, including those that access shallow rearing habitats within the estuary.

Higher resolution questions include:

--Do large subsidies of hatchery fish affect the use of restored habitats by naturally produced salmon? Is life history expression by naturally produced salmon unaffected by phenotypic or genetic selection in hatcheries?

--Do large subsidies of hatchery salmon drive predation pressures, competition, or cause other ecological interactions within the estuary?

--Do ecological interactions associated with hatchery programs influence the estuary's capacity to support a diversity of naturally-produced life history types from at-risk populations?

--Are the survival benefits derived from estuary restoration projects independent of hatchery production levels in the basin?

Genetics and Stock Composition

What is the stock-specific residency and use of various reaches of the estuary?

It is unclear what restoration projects are needed to benefit individual stocks of interest.

Higher resolution questions include:

--Can we improve spatial and temporal resolution to existing estuary-wide analysis?

--How do genetic patterns that we see in the estuary compare to hatchery inputs, fish entry at Bonneville, or historical production?

--What does the historical stock production or habitat capacity suggest about restoration potential and priorities upriver and in the estuary?

Scientific Basis for Estimating Salmon Survival Benefit Units

What ecological measurements best estimate SBU's for various restoration actions?

SBU's have been developed as a surrogate for survival. We need validation of whether literature estimates of habitat capacity and opportunity provide a reasonable approximation of the salmon survival response to the restoration actions.

Higher resolution questions include:

--We need to validate whether literature estimates of habitat capacity provide a reasonable approximation of the salmon rearing capacities of the various wetland types (i.e., emergent, scrub-shrub and forested) represented in the Columbia River estuary

--Relative to the module construct, what is the scientific basis for "stream" type SBUs? We weighted the "ocean" type use, but have avoided a secondary weighting with stream type (primarily hatchery) fish.

- By what criteria can stream-type SBUs be determined?
- What data are needed to assign SBUs for salmon with stream-type (yearling) life histories
- Do hatchery stream type salmon benefit from restoration actions to the same level as wild stream type salmon?

--Do non-native fish species (e.g., killifish, centrarchids, etc.) represented along the estuary tidal gradient limit the potential salmon rearing capacities of restoration projects?

--How does rearing capacity vary seasonally with changes in temperature and flow?

--How does the "peaking" cycle at the dams influence rearing opportunities and capacities at upper estuary restoration sites?

--Do differences in salmon residence times (i.e., turnover rates) significantly influence the estimated rearing capacities of restoration projects in different types of wetlands?