A framework for assessing restoration performance: a case study from the Nisqually River Delta

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Executive Summary: The restoring Nisqually River Delta is comprised of a changing landscape mosaic. Some benefits to salmonids have been rather rapid (Opportunity and habitat access), whereas some restored channels may take longer to return to reference conditions (i.e., low water temperatures), presumably because vegetation structure will be slower to progress to reference conditions in subsided areas. To monitor the impact of the restoration on fish, we examined three metrics of restoration success: Opportunity, Capacity, and Realized Function (as in Simenstad and Cordell 2000).

What did we measure?

- Surface elevations in relation to hydrology, provides crucial information on inundation regimes that can be used to determine the degree of accessibility to fish and waterbirds alike, and habitat connectivity, as well as critical inundation periods for colonizing vegetation and invertebrates.
- Hydrodynamic and sedimentation models (led by Grossman) provide a measure of connectivity of the Nisqually River to the nearshore environment for water and sediment flux.
- Biophysical monitoring (led by Woo, Davis, and De La Cruz) was distributed across the restoring landscape with comparisons at a ‘reference’ unaltered marsh. Measured: channel morphology, water quality, tidal elevation, SETs (Surface Elevation Tables), sedips, hydrology (level, temp, salinity).
- Monitoring priorities for fish and wildlife (led by Ellings and Nakai).

What did we learn?

- Over 900 acres have been restored by the US Fish and Wildlife Service and the Nisqually Indian Tribe at the Nisqually River Delta.
- Available fish habitat increased by 45% across the restored river delta.
- Channel length increased 131% following the 2009 restoration.
- Tidal inundation model indicates that major channels were accessible to juvenile Chinook up to 75% of the time post-restoration, compared to only 30% pre-restoration (Ellings et al. 2016).
- Outmigrating salmon were detected in restored tidal channels.
- Sedimentation is key physical driver for tidal marsh processes and sediment transport models can help managers envision future scenarios (Grossman et al. in prep).

What did we measure?

- Vegetation, invertebrates, and bird monitoring (led by Woo, Davis, and De La Cruz) was distributed across the delta.
- Invertebrate Capacity
  - Restoring vs. Reference tidal marsh (benthic, aquatic, and terrestrial invertebrates)
  - Onshore-offshore gradient (Rubin and USGS WERC)
- Carbon stock and greenhouse gas (tidal marsh functioning for carbon sequestration, led by Woo, De La Cruz, Windham-Meyers, Byrd, Drexler, and Thorne).
- Nearshore eelgrass monitoring (led by Takesue and Stevens) post restoration mapping eelgrass beds using sonar.
- Fish monitoring (led by Ellings) to document opportunity and realized function of restoring estuary and presence over time.
- Nearshore fish, eelgrass (led by Rubin)

What did we learn?

- Greater plant species richness was associated with higher elevations but not with salinity (Belleveau et al. 2015).
- Physical changes due to large scale restoration have major impacts on invertebrate communities. Some taxa are quick to respond (benthic amphipods & cumaceans), don’t change much (aquatic copepods and nauplii), or take longer to recover (terrestrial dipteran larvae; Woo et al. in prep).
- Benthic communities across the restoration area are slowly becoming similar to the nearshore sites (Rubin et al., in prep).
- Eelgrass cover remained relatively constant in areas where sediment texture was fine, but slight declines were recorded in areas with coarser sediments (Takesue 2015).

Key Products


Products in Prep

- Monitoring Lessons Learned (Ellings, Nakai)
- Rubin, S., M. Davis, I. Woo, S. De La Cruz, et al. in prep. Invertebrate niche to estuarine gradient.

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