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Salmonid distribution and abundance in the context of Elwha River dam removals

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Nearshore salmonid distribution and abundance in the context of Elwha dam removals

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Introduction

Removal of two dams on the Elwha River, Washington occurred between 2011 and 2014. This restored natural sediment inputs to the nearshore marine environment near the river mouth. Juvenile salmonids (Chinook, coho, pink and chum salmon) migrate through this region, which also supports ecologically important forage fish and endemic benthic fauna. Since 2006, we have been collecting data on shallow subtidal fish communities near the Elwha River and at reference sites in the Strait of Juan de Fuca to assess fish response to sediment changes resulting from dam removal.

Understanding what biotic and abiotic factors contribute most to this variability in salmon abundance and distribution may help tailor future dam removal processes or reframe management decisions to protect these species at risk.

Objective: Describe spatial and temporal variability in the salmonid community associated with nearshore habitats over a 10-year period in the Strait of Juan de Fuca.

We assessed monthly, inter-annual, and regional variability in salmonid abundance and community composition to describe how communities and species changed in time and space. Additionally, we analyzed responses by individual species in the marine nearshore, including Chinook salmon *(Oncorhynchus tshawytscha*), to removal of Elwha River dams.

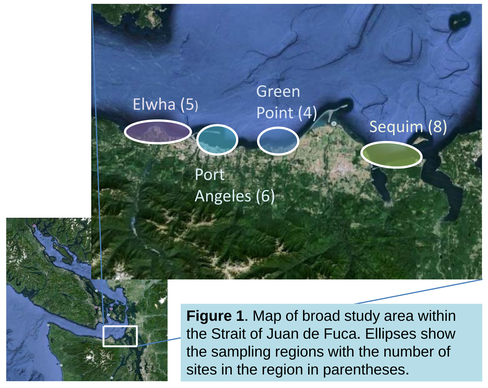

Figure 1. Map of broad study area within the Strait of Juan de Fuca. Ellipses show the sampling regions with the number of sites in the region in parentheses.

Methods

- Sites in 4 geographic regions (Fig. 1): Elwha (immediate vicinity of river mouth, expected sediment impact from dam removals occurring 2011-2014), Port Angeles (protected area), Green Point (geomorphology similar to Elwha sites), and Sequim (far west reference, no dam-related sediment distribution changes).
- Monthly sampling April – September in 2006-2008, 2010-2012, 2014-2017 (weather and tides permitting) with a Puget Sound beach seine (37m long).
- Process: Identify catch to species, count all, measure a subsample (20 individuals per species). Record salinity, temperature, dissolved oxygen, and conductivity.
- Analyses: Bayesian modeling framework and multivariate analyses. Models explaining Chinook salmon abundance included dam/region, year, month, and site effects.

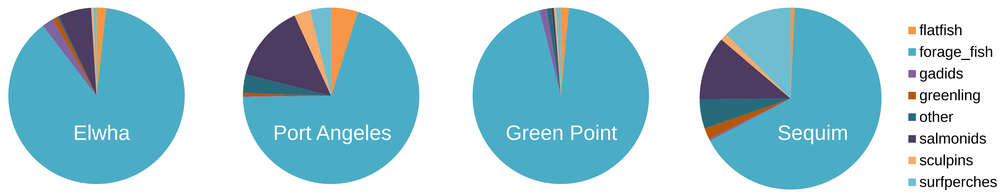

Figure 2. Contribution of different fish groupings to overall catches by sampling region.

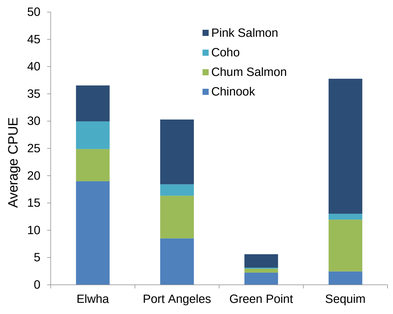

Figure 3. Average CPUE (catch per unit effort) of salmon by region.

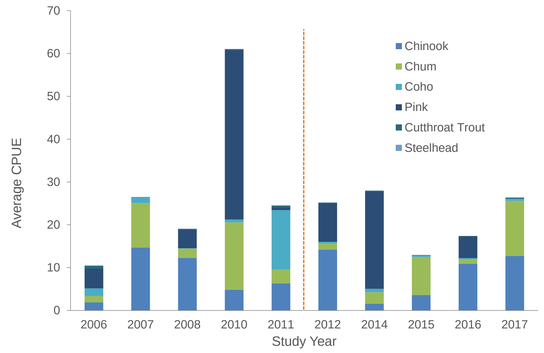

Figure 4. Average CPUE of salmonids by year. Dashed line marks completion of a majority of the dam removal process and associated sediment releases.

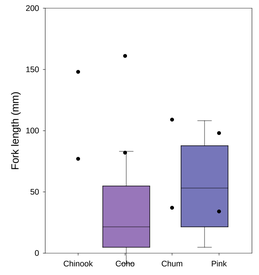

Figure 5. Average fork lengths (mm) of salmon caught by species.

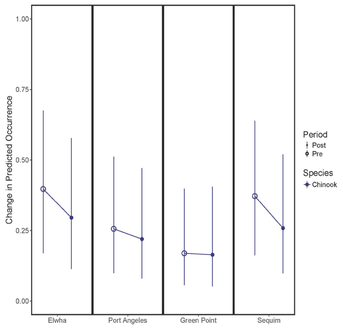

Figure 6. Model output of the effect of dam removal on the probability of catching at least one Chinook salmon, by region.

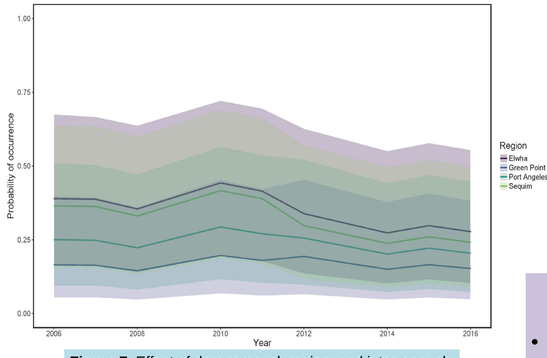

Figure 7. Effect of dam removal, region, and inter-annual variability on probability of occurrence of Chinook salmon.

Results

- We catch a LOT of fish: A majority of our catch is dominated by forage fish (Pacific herring, Surf smelt, etc.) followed by salmonids (Figure 2).
- Annual average catch per unit effort (CPUE) for catches of all salmonids is highly variable (Figure 4).
- Sampling regions influence CPUE. Green Point has the lowest catches of salmonids (Figure 3) despite having the highest abundance of forage fish prey. High CPUE in the Elwha and Sequim regions could be due to their proximity to salmon-producing streams.
- For Chinook salmon the probability of occurrence (catching at least one fish/set) is not markedly different between pre- and post- dam removal periods at sites most influenced by sediment influx (Elwha and Port Angeles) or reference regions (Figure 6). However, there was a decreasing trend in probability of occurrence following dam removal, particularly in the Elwha and Sequim regions (Figures 6, 7).
- Marked hatchery fish comprise 12% and 20% of total catches of Chinook and coho salmon, respectively.

Figure 8. The plume of suspended sediments at the mouth of the Elwha River. Photo by Tom Roorda and CWI, 30 August 2015; used with permission.

Discussion

- Localized differences had large impacts on community demographics. Nominally similar sites may be subject to fine scale differences that drive important aspects of community composition.
- Coho and Chinook salmon tended to be larger than the other salmonids caught for this study (Figure 5). This reflects differences in sizes of these species when they move out of natal streams. Coho and Chinook salmon also tend to utilize shallow marine waters longer as nursery grounds or for refuge.
- The release of sediments due to dam removal has generated local changes in habitat. However, we have not seen a strong localized response by salmon species to this change. These fish species are not strongly dependent on small geographic areas, so sudden changes (like sediment influx from dam removal) may not drive a response even at the local scale. There is evidence of a regional decrease in catching Chinook salmon, which warrants further exploration.

Acknowledgments

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who beach seined over the years.