Marine Fish and their Habitat:
Analyzing How Fish Use the Strait of Juan de Fuca

Abstract

In 2005 the National Oceanic and Atmospheric Administration, in partnership with the Lower Elwha Klallam Tribe, Batelle Northwest Laboratories, Oregon State University and the Washington Department of Fish and Wildlife initiated a research project in the coastal areas surrounding the mouth of the Elwha River on Washington State's Olympic Peninsula. This project seeks to understand how fish utilizing the shallow sub-tidal and intertidal areas along the Strait of Juan de Fuca will respond to the removal of two dams on the Elwha River and to the restoration expected to follow the removal. The removal of the two dams is expected to deliver sediment, trapped for over 90 years in reservoirs, to the Strait of Juan de Fuca. This information will be crucial in helping to understand how living organisms, especially fish, respond to dam removal.

Introduction

Coastal waters in Puget Sound and the Strait of Juan de Fuca are home to an incredible array of habitats. Occupying these habitats are a large number of fish and invertebrate species that are important as food to many types of birds, whales, seals and other fish. Many of the fish and invertebrates occurring in the coastal waters are also important economically. The upcoming removal of two dams on the Olympic Peninsula's Elwha River will change coastal habitats (Warrick, 2005) and potentially alter the lives of some species that live near the mouth of the Elwha River. Kurt Fresh, a scientist working for the National Oceanic and Atmospheric Administration, along with researchers from the Lower Elwha Klallam Tribe, Batelle Northwest Laboratories, Oregon State University and the Washington Department of Fish and Wildlife, want to learn how fish found near the mouth of the Elwha River will respond to the removal of the dams and to the restoration expected to follow the removal.

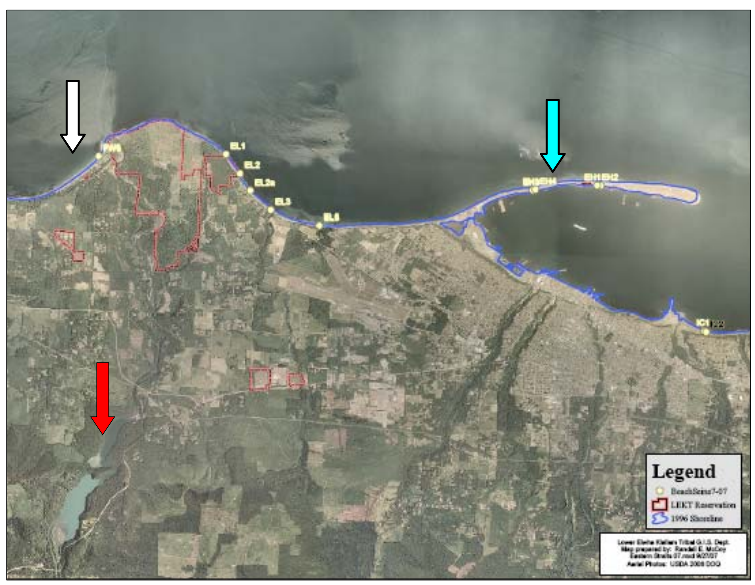

Figure 1: Map showing the Elwha River Mouth (white arrow), Ediz Hook (blue arrow) and the lower Elwha dam (red arrow). Project sample sites are shown in yellow. Map prepared by Lower Elwha Klallam Tribe GIS Department.

The Elwha River drains the rugged Olympic Mountains and flows north into the Strait of Juan de Fuca. Construction of two dams on the river in the early 1900s helped fuel the development of Port Angeles and the North Olympic Peninsula, but also resulted in the reduction of the Elwha River's huge salmon runs. Additionally, over the 90+ year history of the two dams almost 18 million cubic yards of sediment has built up in their reservoirs. This volume of sediment is equivalent to a line of dump trucks, all full of Elwha River sediment, lined up bumper to bumper and stretching three times across the United States! This is a huge amount of sediment that, if not intercepted by the dams and stored in the reservoirs, would have made it to the coast. In coastal areas, sediments are critical to the formation and maintenance of coastal habitats, such as eel-grass beds, kelp beds, and mudflats, which fish rely on. When the dams are removed it is expected that almost half of the sediment currently trapped in the reservoirs will eventually work its way into the coastal area near the mouth of the Elwha River (Randle, et al. 1996).

Fresh hypothesizes that sediment exiting the Elwha River during and after dam removal could change characteristics of some of the coastal habitats along the Elwha coastline. As a result, the abundance, sizes, and types of fish found in areas where habitats change might be altered as well. Fresh is specifically looking at fish in intertidal and shallow subtidal habitats – areas nearest to the land. Previous work has shown that habitats in this zone are used by a variety of species fish for rearing, or raising, of young fish, and by some species for reproduction; therefore, it can be of particular importance to sustaining future generations.

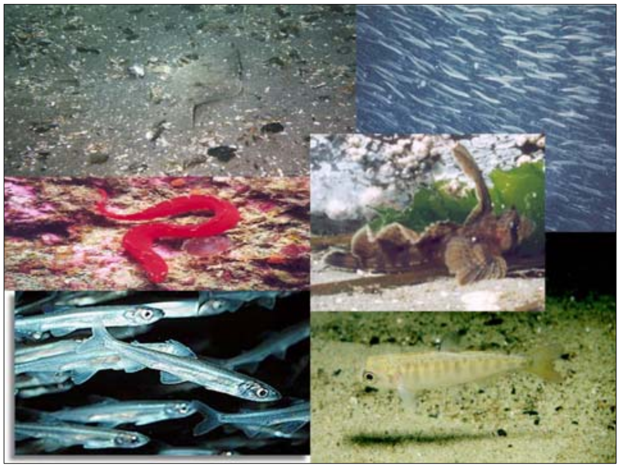

Figure 2: Some of the intertidal and nearshore species of fish found in coastal waters of Puget Sound and the Strait of Juan de Fuca. Clockwise from top left: English Sole, Sand Lance, Sailfin Sculpin, Chinook Salmon, Surf Smelt, Longfin Gunnel

With this study, Fresh is attempting to address the following research questions:

1. How do fish using intertidal and shallow subtidal habitats near the mouth of the Elwha River respond to the habitat changes expected to result from the removal of the two dams on the Elwha River? For example, can changes in the abundance or distribution of some species be detected? Can changes in food web relationships be detected?
2. What salmonids use habitats in the central Straits of Juan de Fuca around the mouth of the Elwha River, what do they do there, and where do they come from?

Methods

To address these questions Fresh is using the following methods:

Figure 3: A beach seine net as it is pulled to shore by a team of researchers. Photo by NOAA Fisheries

1. **Beach seining.** This method involves pulling a net through the water directly off of the beach. The net is pulled on to the beach and its contents of fish are then identified, and various types of data are collected. This method allows a researcher to understand which fish are in a particular area, sizes of these fish, and in what quantities.

2. **DNA and coded-wire tag analysis.** These two methods can be used to determine where Chinook and coho salmon collected in the beach seine originated. Salmon are examined for the presence of a missing adipose fin and/or a coded wire tag, both of which indicate that a fish was born in a hatchery. If a coded wire tag can be recovered from the fish, the hatchery of origin can be determined as well as when the fish was released. A small sample of tissue is also collected from wild Chinook salmon (those that were not born in a hatchery) for later DNA analysis, which can reveal the birth stream of wild Chinook Salmon.

3. **Diet analysis.** This method involves examining the stomach contents of fish to determine what they are eating. A technician works with a microscope to pick apart the contents from a fish's stomach and attempts to identify the items. This is hard and exacting work, but is crucial to understanding how young fish survive, and what they eat.

4. **Sampling of the "benthos" and "epibenthos".** The benthos is the bottom of the sea and the epibenthos is the very top most layer of the bottom of the sea. As part of this study, Fresh wants to know what types of small invertebrates are using the sediments near the shoreline as habitat. Many small fish eat these tiny invertebrates, and knowing what types of invertebrates are out there, and in what abundances, is critical to understanding how small fish survive in their habitats.

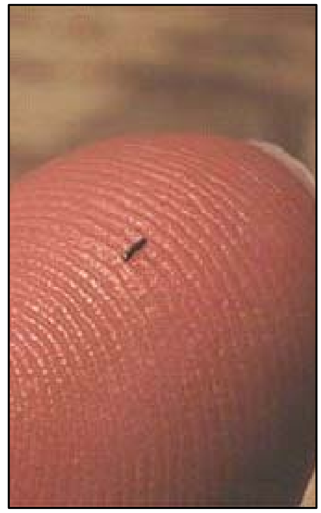

Figure 4: A Coded Wire Tag shown on a human finger. This tag is injected into salmon or other fish. Photo courtesy of the Irish Marine Institute

Discussion

This research project started in 2005. Sampling that takes place before the removal of the dams can be defined as "baseline monitoring". Baseline monitoring allows scientists to understand the Elwha coastal ecosystem in its present form and better create hypotheses addressing how they think it will change once the Elwha River dams are removed. Baseline monitoring also allows them to select certain species or groups of species to focus on as indicators of change. These species will get extra attention in the years during and following dam removal.

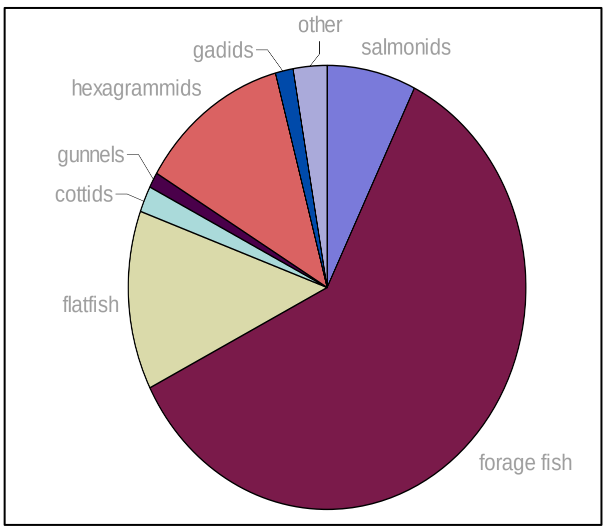

Figure 5: Species composition from all seines in 2006. A total of 45 species were collected, with surf smelt as the most abundant species and pink salmon the most abundant salmonid.

Already, Fresh has observed patterns in the environment from this project that, if they continue to be observed during sampling, could lead to new studies and new knowledge. For example, in 2006 Fresh collected over 130 beach seine samples, and identified fish caught in those seines. One species of fish, anchovy, was not found in any of those samples. In 2007, however, anchovy were caught in many samples. Anchovy are considered a very important fish in coastal ecosystems as they are eaten by a wide assortment of birds, mammals and other fish (and people!). Determining why their abundance fluctuates so dramatically from year to year is an important learning objective.

References

Randle, T.; Young, C.; Melena, J.; and Ouellette, E. 1996. Sediment Analysis and Modeling of the River Erosion Alternative. U.S. Bureau of Reclamation Document ETS-PN-95-9.

Warrick, J. 2005. Dam Removal on the Elwha River in Washington—Nearshore Impacts of Released Sediment. Sound Waves, February 2005 edition.

Glossary

Coded-wire tags: Coded-wire tags are injected into many salmon born not in streams but in salmon hatcheries. If a salmon is determined to carry a coded-wire tag (the coded-wire tag causes a small sensor to beep when the young fish is passed in front of it – kind of like scanning for prices at the grocery store!) it is known that the fish came from a hatchery, and the exact hatchery and the date of its release can be determined by examining the tag under a microscope.

DNA: Short for deoxyribonucleic acid. The nucleic acid that is the genetic material determining the makeup of all living cells and many viruses. Analysis of this material from an organism can allow a researcher to determine the genetic relationship between other organisms.

Food web: The sequence of the transfer of food energy from one organism to another in an ecological community

Habitat: The area or natural environment in which an organism or population normally lives

Intertidal: Relating to the region between the high tide mark and the low tide mark along a beach or coast.

Reservoir: A natural or artificial pond or lake, created when dams block or slow the flow of a river or stream, used for the storage of water.

Salmonids: A general term referring to any of the many species of salmon.

Sub-tidal: Relating to the region below the low tide mark along a beach or coast.

Researcher Biography

Kurt Fresh, in orange, examines the contents of a beach seine.

Kurt Fresh, NOAA, Northwest Fisheries Science Center

Kurt Fresh's career in fisheries began when his father and mother bought him his first fishing rod and reel. He became fascinated with fish: Why could you find them in one place on Monday and another on Wednesday. Why did they come in some many sizes and shapes? Eventually, his questions led him to a Masters Degree at the University of Washington. He decided to specialize in fish ecology because it integrates all things about the fish AND their environment. Salmon are the kingpin fish in the Pacific Northwest, and Kurt eventually gravitated to the world of salmon ecology and estuaries. After 20 years at the Washington State Department of Fish and Wildlife, Kurt moved to NOAA where he conducts research on the estuarine ecology of salmon. This includes working to understand the biological responses to removal of the Elwha River dams, which is a once in a career experience – dams, after all, are not knocked down every day!

Curriculum Writer's Biography

Ian Miller, M.S. Candidate University of California Santa Cruz

Ian Miller is in his first year of graduate studies at the UC Santa Cruz in California studying beach and coastal sediments and the ways that their movements create habitat for marine organisms. And yes, you guessed it, his study site is the coastal zone in front of the Elwha River mouth. Prior to starting graduate school Ian lived lives as a world traveller, Washington Field Coordinator for the Surfrider Foundation and Education Director at the Olympic Park Institute. In his spare time Ian enjoys immersing himself in cold salt water.

Elwha Research Learning Unit

This research summary is a piece of a larger Elwha Research Learning Unit which has been funded by the Research Learning Network and coordinated by Olympic Park Institute. This is one of seven research summaries which capture the diverse and exciting science which is being done in preparation for the upcoming Elwha River dam removals. All seven summaries are examples of the important work which fits together to help us better understand the Elwha River Ecosystem and neighboring Strait of Juan de Fuca. Three of these research topics have been turned into activities which have been designed for us to practice the scientific process by using real research from this inspiring dam removal effort. For the complete learning unit, go to OlympicParkInstitute.org or ElwhaScienceEd.org.

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