Integrating estuaries in a whole watershed perspective on salmon

Interest in restoring salmon habitat throughout the Pacific Northwest has increased greatly in recent years with the widespread decline of Pacific salmon. Although some salmon populations have rebounded in the last few years with improving ocean conditions, the abundance of wild salmon populations, upon whose genetic diversity secure future runs depend, are still severely depressed in general.

View of the Salmon River estuary (left), from Cascade Head.

Nearly all the attention in salmon restoration science and practice has focused on the watersheds where salmon spawn and develop as juveniles. While watersheds are composed of a number of ecosystems from the ridge crest to the sea, most of the salmon-related research has focused on inland elements away from the shore, on the uplands, and on the exclusively freshwater parts of the rivers.

Estuaries—where salmon species acclimate to tidal and saltwater environments—generally have been neglected. A multiyear project on Oregon's Salmon River addresses the need for better ecological understanding of these vital environments.

Oregon Sea Grant's support of Salmon River research began in 1998 and is exceptional, in a couple of senses. In the past decade Sea Grant generally has ceded support of field research on salmon to other, better-funded organizations, partly because it wasn't clear where Sea Grant could make the most difference. When estuaries emerged as a new area of interest, Sea Grant responded by funding Salmon River projects in more total dollars than any other set of closely related projects in recent program history.

Intertidal marshes are the focus of the Salmon River estuary research, which is led by principal investigators Dan Bottom, NOAA-Fisheries, Northwest Fisheries Science Center; Kim Jones, Oregon Department of Fish and Wildlife; and Charles Simenstad, School of Aquatic and Fishery Sciences, University of Washington. Although such marshes are natural to the Oregon coast, as much as 80 percent of them have been lost since the mid-1800s, most as a result of diking. Breaching the dikes to restore tidal inundation represents one of the few viable options for large-scale restoration of estuary habitat, many scientists believe. Such projects are often promoted as a method of salmon recovery, but the role of estuary marshes in the life histories and production of juvenile salmon in Oregon has previously been poorly known.

The Salmon River estuary lies within the Cascade Head Scenic Research Area, established by Congress in 1974 and managed by the U.S. Forest Service. Since 1980 this special locale has also been part of the United Nations Biosphere Reserve system. The removal of three dikes on the Salmon River in 1978, 1987, and 1996 provided project researchers with a series of restoration experiments in successive stages of recovery that could be compared to an undiked reference marsh.

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To date, researchers at Salmon River have found the following.

- Marsh habitats are consistently used by naturally produced juvenile chinook and coho salmon from early spring (March–April) through July or later.
- Chinook salmon were most abundant among salmonid species and made use of restoring wetlands even soon after dikes were removed.
- Estuarine marshes may be more important to juvenile coho salmon than has been previously recognized.
- Juvenile salmon grow approximately 0.5 mm per day (June and July) in estuarine marsh habitats.
- Factors explaining variability in fish use at each marsh site include differences in vegetation and channel morphology, channel access, and the location of each marsh along the tidal gradient.
- As compared to the undiked reference marsh, each restoring marsh has a somewhat different array of prey resources available to juvenile salmon, which is reflected to some degree in the salmon's diets.
- Juvenile chinook salmon often fed more effectively, from the standpoint of energy consumed, in restoring marshes than in the undiked reference marsh, but higher temperatures (caused by tidal channel geomorphology and little overhanging vegetation) in the youngest (1996) restoring marsh prevented them from gaining any extra benefit from the higher consumption.
- Fry and fingerlings arrived earlier throughout the spring and early summer of 2000–02 relative to a previous benchmark, 1975–77, perhaps in response to increased rearing opportunities in the estuary that followed the restoration of diked wetlands.
- Slightly larger fry or fingerlings that arrive in June after rearing upriver for a time were not present in the 1975–77 surveys, which suggests an increase in life history diversity.
- On the other hand, relatively few of the earliest fry migrants may have reached the ocean in 2001 and 2002. Most of the early spring arrivals to the estuary are the offspring of adults that spawn in the lowermost section of the Salmon River, and most of these chinook adults probably derive from the Salmon River Hatchery, which began releasing juveniles in 1977.

These findings led the researchers to these key insights:

- Juvenile salmon indeed make use of restoring marsh habitats.
- The use of marshes by salmon can be affected by geographic, geomorphic, and other factors as much as by the time elapsed since dike removal.
- Management actions that affect the geographic structure and life histories of salmon populations upriver ultimately might determine whether juveniles can take full advantage of natural or restoring rearing opportunities in the estuary.

The researchers believe their results illustrate the need for whole-basin approaches to salmon conservation and recovery, a principle which they're elaborating as they examine other estuaries on the Oregon coast in the final phase of the project.

Although major financial support for the Salmon River Study has been provided by Oregon Sea Grant, a hallmark of the project has been its collaborative nature. Other regional parties have seen the value in the study and have extended its value with multidisciplinary efforts. Among these efforts and cooperators are

- aerial photography and GIS analysis of physical habitat conditions (U.S. Forest Service - USFS)
- analysis of marsh vegetation and channel changes (USFS and supplemental Sea Grant funding)
- application of new microprobe techniques for analysis of salmon otoliths (Washington Department of Fish and Wildlife)
- pilot testing of methods for evaluating importance of large wood to juvenile salmon (Siletz Tribe)
- marking and assessment of fish movements throughout the system (Oregon Department of Fish and Wildlife)

The other members of the research team include Ian Fleming (OSU), Trevan J. Cornwell (ODFW), Eric Volk (WDFW), and Ayesha Gray (UW).

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