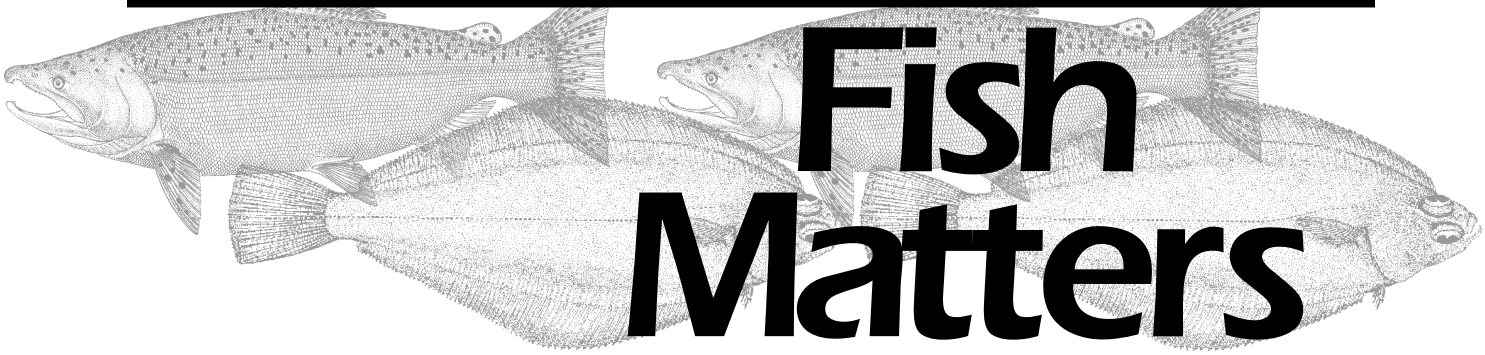
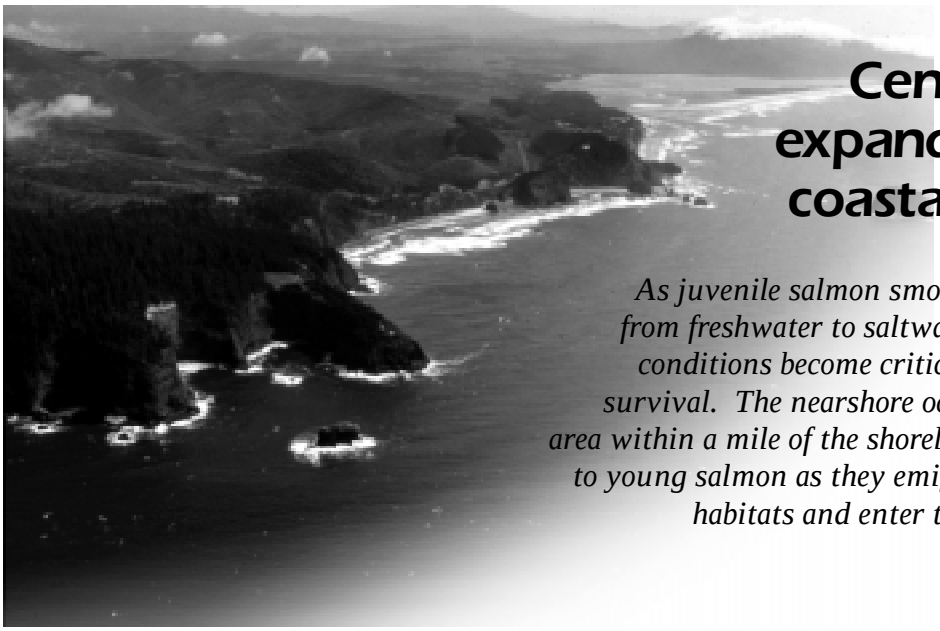
Northwest Fisheries Science Center



Fish Matters



Center scientists expand research on coastal ecosystems

As juvenile salmon smolts make their transition from freshwater to saltwater, estuarine and ocean conditions become critical factors affecting their survival. The nearshore ocean zone (including the area within a mile of the shoreline) is especially critical to young salmon as they emigrate from their riverine habitats and enter the marine environment.

Scientists with NOAA Fisheries' Northwest Fisheries Science Center are conducting studies that probe links between coastal ocean conditions and salmon productivity. Because the estuarine and early ocean phase of the salmon life cycle has been relatively understudied, this research is a key element in enhancing fishery managers' ability to distinguish between natural variability and atypical changes in salmon populations.

"Data must go beyond single species abundance and include empirical information and indices that identify and quantitatively describe within- and among-year variability in oceanic and estuarine conditions, recruitment, fish growth, and predator-prey and multi-species interactions," says Dr. Ed Casillas, Manager for the Estuarine and Ocean Ecology Program. "By taking a more holistic ecological approach, we will advance our ability to make predictions of fishery yields through a combination of modeling, retrospective analysis, and process research."

Results of the Center studies will be important to policy decisions aimed at restoring severely depressed Pacific salmon runs. This issue of *Fish Matters* highlights some of the ocean and estuarine ecology projects underway at the Center.

Northwest Fisheries Science Center

National Marine Fisheries Service

National Oceanic and Atmospheric Administration

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March 2000

The Estuarine and Ocean Ecology Program

of the Northwest Fisheries Science Center
is a broad-based effort to develop an ecosystem context for managing salmon stocks off the Pacific Northwest coast

Research Goals

In support of salmon recovery and sustainability goals, the Northwest Fisheries Science Center:

- Correlates juvenile salmon production with biological and physical properties of estuarine and marine environments, including aspects of regional-scale oceanic structure
- Evaluates the influence on salmon of important trophic interactions (predator abundance, prey availability, influence of disease) and physical factors (temperature, ocean upwelling, plume conditions) in coastal waters
- Provides critical information on the role of predation as a source of salmon mortality in the nearshore ocean

Key Partners

NOAA Fisheries
Bonneville Power Administration
University of Washington
Oregon State University
Oregon Graduate Institute
Oregon Department of Fish and Wildlife
University of California
Canadian Department of Fisheries and Oceans

Is the Columbia River plume a special place for salmon?

The Columbia River plume is the area where river flows interact with the California Current (a broad, slow-moving, southward flow of cold water along the Oregon and California coasts). The plume is a blend of freshwater and saltwater that creates a large and unique habitat for young salmon.

To better understand the plume's importance to juvenile salmon production, scientists with the Northwest Fisheries Science Center are correlating juvenile salmon growth, health, and survival with ocean food-web structure and other biological and physical conditions in the Columbia River plume and adjacent coastal waters. A major focus of summer sampling cruises is to relate the growth and bioenergetic health of juvenile chinook and coho salmon to the Columbia River plume, available prey fields, and oceanographic conditions at the time of sampling. Scientists also will compare their data to historical information on the distribution and abundance of juvenile salmon from the region.

Questions the scientists are attempting to answer include:

- Are juvenile salmon more abundant in the plume than elsewhere along the Washington-Oregon coast?
- Are growth rates and overall weight and length higher?
- Do higher nutrient concentrations enhance food availability?
- Could survival increase if river flows of the Columbia River are regulated differently?

Last summer, Center scientists chartered the commercial fishing trawler FV *Sea Eagle* and the Canadian Coast Guard fisheries research vessel *W.E. Ricker* for a series of cruises off Washington and Oregon. Researchers collected juvenile salmon and other fish species with a surface trawl at various sampling stations along nine main transects. At each trawl site, Center scientists also collected biological data (e.g., chlorophyll and nutrient samples) and physical data (e.g., temperature and salinity) that will reflect the associated zooplankton prey field and oceanographic conditions at those locations.

Sampling will continue this summer, and will extend through northern British Columbia in collaboration with Canadian researchers.

Columbia River mouth at Pacific Ocean

The climate connection

A growing area of research at the Northwest Fisheries Science Center is the role of changing ocean conditions in the declines of Pacific salmon and West Coast groundfish stocks. Ocean climate dynamics keep the coastal food web in flux, sometimes altering predator-prey relationships and harming young salmon. Pacific Ocean conditions have been generally unfavorable for salmon off the Pacific coast since the late 1970s, when a regime shift brought warmer water temperatures to the North Pacific.

A highly integrative team is being assembled as part of the Northeast Pacific Initiative of GLOBEC (U.S. Global Ecosystem Dynamics). Scientists from the Northwest Fisheries Science Center are part of this expansive effort between university and federal scientists, who seek to better understand the effects of climate-ocean variability on salmon productivity.

Process studies beginning in 2000 will assess salmon productivity in relation to physical and biological conditions in the coastal region near Cape Blanco, Oregon. The California Current is known to move offshore, forcing the development of different oceanographic environments north and south of Cape Blanco. Center scientists plan to conduct their first mesoscale surveys and process cruises in summer 2000.

"The need to understand the direct and indirect linkages between oceanographic conditions and salmon survival in the marine environment is becoming more critical as the number of ESA-listed salmon stocks increases. Long-term regime shifts in climatic processes affect oceanic structures and have produced abrupt differences in salmon marine survival and returns.

Increasing our understanding of nearshore ocean environments, and the linkages to oceanographic conditions and the role they play in salmonid survival, could provide management options to increase adult salmon returns."

Dr. Michael Schiewe , Director
Fish Ecology Division

Ocean feeding and growth of juvenile salmon

Changes in the ocean conditions off the Pacific Northwest coast may be influencing juvenile salmon by affecting both the food they eat and the predatory fish that eat juvenile salmon. Significant changes that may be detrimental to salmon include changes in the pelagic nekton community, large increase in Pacific hake biomass, an increase in Pacific sardines, and a reduction in northern anchovy biomass.

Scientists at the Northwest Fisheries Science Center are attempting to better understand these food chain relationships to help determine their role in the decline of salmon runs. Center scientists are working collaboratively with university researchers in a series of related studies.

Ocean Conditions off Oregon. At-sea sampling along a standard transect line off Newport, Oregon is being conducted to determine whether zooplankton occurrence has changed as a result of a climate-regime shift in the 1970s. Scientists postulate that interannual variations in coho survival are related to variations in zooplankton biomass. Center scientists are collecting data to provide descriptions of the temporal variations in the prey fields of salmonids in the Oregon coastal waters, and to compare prey fields now to similar historical datasets collected in 15 previous summers. Data comparisons will help determine whether significant changes in biological productivity have occurred in the upwelling zone, and to what extent the changes (if observed) are related to changes in abundance of pelagic fishes.

Food Habits and Trophic Ecology. A study by Center scientists focuses on alterations in predator-prey relationships linked to El Niño changes in ocean currents. This project not only examines the diets of juvenile salmon, their predators, and competitors, but also quantitatively compares juvenile salmonid prey type and size to what is available in the water column. Moreover, this study postulates that as warmwater predators (such as Pacific mackerel) are swept northward by El Nino currents, young salmon are increasingly the prey species as the abundance of northern anchovy and other alternate prey declines.

Ocean Ecology. In a project that characterizes the ocean ecology of North Pacific salmonids, Center researchers are examining the links between the rates of growth of juvenile coho salmon soon after they enter the ocean, and their ultimate survival to

adulthood. Data suggests that complex interactions among factors such as predator and prey abundance and fish health may play more important roles than variation in growth rates in determining year-class success. .

Wind-Driven Circulation. Center researchers are studying wind-driven circulation patterns and the influence on recruitment of prey resources onto the Oregon and Washington coastal shelf. Scientists feel that advection of zooplankton onto the coastal shelf is the primary process affecting zooplankton prey abundance in coastal marine waters. Sampling will continue through 2000 off Newport, Oregon.

Marine Fish Predation on Salmon. A study by Center scientists is identifying whether large marine fish predators off the mouth of the Columbia River are a significant source of juvenile salmonid mortality in the nearshore coastal environment. Scientists have postulated that as warmwater fish predators such as Pacific mackerel are swept northward by El Niño currents, young salmon are increasingly the prey species as the abundance of northern anchovy and other alternate prey declines. In addition to providing information on the abundance of marine fish predators, this study will identify the feeding habits of predatory fishes, how their feedings habits are affected by oceanographic conditions and baitfish abundance, and estimates of numbers of salmonids consumed.

Estuaries: a critical point of passage

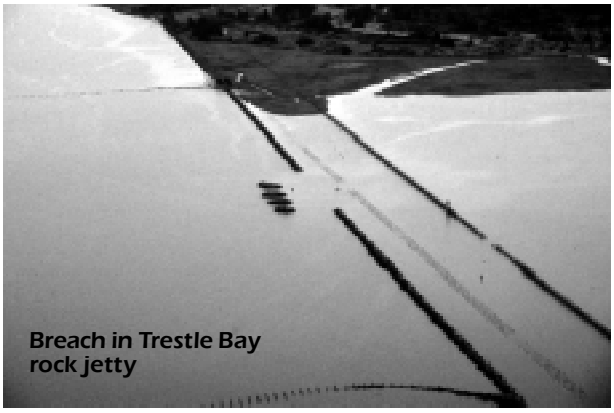
Studies are underway at the Northwest Fisheries Science Center that illustrate the importance of estuaries to salmon survival.

Conceptual Model. Center scientists are developing a conceptual model describing which attributes of estuaries, particularly the Columbia River estuary, support the various salmon life history patterns historically present in the Pacific Northwest. The model outlines the salmon species and life history types that were known to use the estuary. It also identifies the possible role played by estuarine habitats in supporting these species and life history types.

The model provides a way to compare the historical and present-day interactions of salmon with the estuary. By overlaying the loss of salmon species and life histories onto the changes in estuarine conditions, scientists can identify important linkages between estuary processes and salmon survival. Factors to be examined include historical and future changes in the estuary due to climate, hydropower development and operation, and other human-caused alterations.

Scientists have evaluated current modeling capabilities, assembled a description of climatic changes of the past 100 years that affect flow and sediment inputs into the system, and collected available literature relating to salmon use of the Columbia River estuary for the past 100 years. Current activities include modeling changes in the amount of low velocity, shallow-water habitats in the estuary from the historical period (1800s) to the present.

Reclaimed Estuarine Habitat. Two Center studies focus on the importance of reclaimed estuarine habitats. In a project completed last year, Center researchers found that breaching a rock jetty in an area known as Trestle Bay restored fish access into the highly productive bay from the adjoining Columbia River estuary. The jetty breach not only restored fish access to the bay for juvenile salmonids, but improved forage conditions for other important recreational and commercial fishes of the lower Columbia River estuary. This successful project illustrated the benefits of low-cost measures that return valuable wetland, intertidal, and shallow subtidal habitats to an estuary.



Breach in Trestle Bay rock jetty

In an ongoing study, Center scientists are quantifying the use and impact on salmon of reclaimed habitats in the Salmon River estuary of central coastal Oregon. This project is examining the relationships between juvenile salmon usage (and associated benefits) of reclaimed estuarine habitat that are at various stages of reclamation: namely, 20 years, 10 years, 1 year, and control / unaltered. The effort will document the linkages between estuarine habitat function and salmon abundance, growth, and health.