Food Web Dynamics in the Lower Columbia River Estuary

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Abstract

This talk provides an overview of what is known about food web dynamics in the Columbia River estuary, particularly as they relate to bottom-up and top-down effects on juvenile salmon. From River Kilometer 75 to the mouth, the estuary is a complex, dynamic mosaic of channels, shoals, bays, and wetlands. For purposes of this talk, the estuary can be divided into three regions with temporally-varying boundaries defined by salinity (ocean/plume, estuarine mixing, and tidal fluvial). The organic material used by primary consumers enters estuarine food webs from four main sources: rivers (as freshwater phytoplankton or organic debris), tidally or seasonally flooded habitats (as benthic algae or organic debris from wetland plants), estuarine production in turbidity maxima (as particle-attached microbes), and the coastal ocean (as marine phytoplankton). Primary production by phytoplankton, algae, and sub-surface vascular plants is light-limited due to very shallow light penetration in the water column (photic zone < 2.5 m) and rapid flushing time in the estuary (2-5 days). Decaying organic material (detritus) appears to be the main energy source for many primary consumers, with macrodetritus from wetland habitats fueling the benthic food web, and microdetritus from freshwater phytoplankton fueling the pelagic food web. However, the relative importance of different sources of macro- and microdetritus to food web pathways leading to salmon has yet to be determined, and the extent to which invasive species might alter these pathways is not understood.

Prey types taken by juvenile salmon in the estuary are diverse, and depend on species/life history type, season, estuary location, and interannual variability in prey abundance. Stomach content data imply salmon are linked strongly to several types of imported production: detrital food webs, insect production, and in some cases freshwater cladocerans. The gammarid amphipod *Corophium salmonis*, along with other epibenthic crustaceans, are important prey to most salmon species using the estuary. Stomach data imply that for chinook and coho residing in the estuary for more than a few days, short-term prey availability is not limiting (less than 20% of stomachs are empty), except in June and winter (when up to 20% to 50% are empty). However, little is known about the ecological causes of changes in prey availability (especially interannual

changes); relationships between diet, prey consumption rates, and growth in different habitats; movement patterns of estuary-resident juveniles among different habitats; or the relationship between estuary feeding conditions and smolt-to-adult survival.

Fish predation on juvenile salmon in the lower estuary is thought to be unimportant. Surveys in the early 1980s found only two of over 5,000 predator stomachs contained juvenile salmon; no northern pikeminnow stomachs contained juvenile salmon. During the 1990s, bird predation, especially by breeding Caspian terns, removed on the order of 5% to 17% of juvenile salmon entering the estuary. This predation pressure has been reduced by moving the tern colonies to the Ocean/Plume environment where the birds consume less salmon and more schooling marine fishes. Predation by marine mammals - primarily harbor seals and sea lions - has been difficult to evaluate. Work to obtain indirect estimates from pinniped population estimates and scat analysis is in the early stages. Salmon parasites and disease known to cause mortality in freshwater environments are present in the estuary; work to determine their role in the estuary began in 2001. Anthropogenic mortality agents (e.g. acute or chronic pollution, bioaccumulation of contaminants) are not thought to be significant, although studies in the lower estuary are limited.

One of the most significant challenges facing salmon research in the lower estuary is dealing with strong temporal variation across multiple time scales (tidal, seasonal, interannual) within a spatially complex landscape. This is especially true for biological measurements and rate processes, which unlike physical processes often cannot be measured with high temporal resolution (except perhaps for primary producers), cannot be interpolated across large spatial scales, and do not necessarily remain similar among years.