Southeast Alaska Coastal Monitoring for Habitat Use and Early Marine Ecology of Juvenile Pacific Salmon

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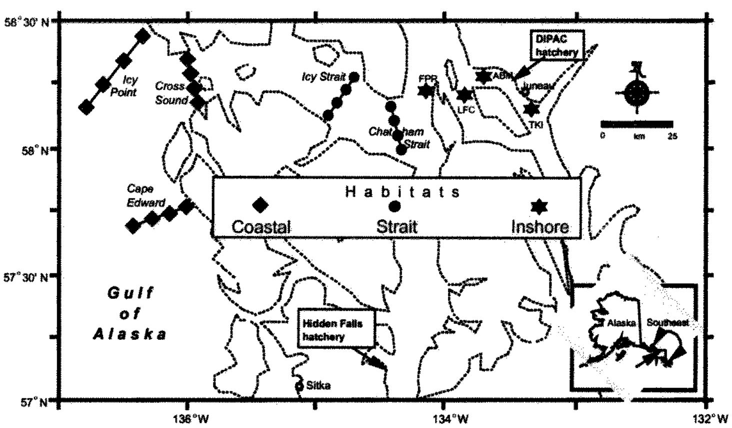
The Southeast Coastal Monitoring (SECM) Project in Alaska was initiated in 1997 to study the habitat use and early marine ecology of juvenile (age-.0) Pacific salmon (*Oncorhynchus* spp). From May through October 1997–2000, biophysical parameters were sampled in inshore, strait, and coastal habitats along a primary seaward migration corridor used by juvenile salmon (Fig. 1). Up to 24 stations spanning 250 km were sampled five times annually. These habitats extend geographically from inshore localities near large glacial rivers to 65 km offshore in the Gulf of Alaska. Sampling was accomplished with a NORDIC 264 surface rope trawl fished from the NOAA ship *John. N. Cobb.*

Fig. 1. Stations sampled in inshore, strait, and coastal habitats of Southeast Alaska, May–September, 1997–2000.



Seasonal patterns in temperature, salinity, and zooplankton abundance were observed. In all habitats, surface (2-m) temperatures generally increased from May–July then declined from August–October. Surface temperatures increased more rapidly in inshore and strait habitats than in coastal habitats; temperatures were similar in all habitats in August, and by September–October the coastal habitats were warmest. Surface salinities in inshore and coastal habitats decreased from May–July, then increased from July–September. Salinity increased seaward, and was highest and most stable in coastal habitats. Zooplankton biomass in 20-m vertical plankton hauls was highest in inshore and strait habitats in May and June, then declined sharply from June–August. Zooplankton biomass was lower in coastal habitats compared to others, but varied less over the season. Therefore, juvenile salmon may follow migration cues of increasing seaward salinity and a seasonal decline in zooplankton biomass in inside waters.

Juvenile salmon were the dominant epipelagic fish in the catch during the trawl sampling. A total of 38,538 fish from 42 taxa were captured with 374 hauls. Five species of juvenile salmon comprised 65% of the catch, with pink (*O. gorbuscha*) and chum salmon (*O. keta*) each representing 29% of the catch. Of the remaining fish species captured, only three comprised > 5% of the catch: sablefish (*Anoplopoma fimbria*, 13%), Pacific herring (*Clupea harengus*, 8%), and capelin (*Mallotus villosus*, 7%). The biomass of these species may be underrepresented because their diel migration minimizes their diurnal occurrence near the surface.

Distribution of juvenile salmon varied by season and habitat. The catch rates of juvenile salmon were zero in May and highest in June and July for most species (Fig. 2). Among the habitats sampled, catch rates were highest in the straits, where declining abundance in August coincided with declining zooplankton biomass. In coastal habitats, catch rates of juvenile salmon declined with distance offshore; most juveniles were captured over the continental shelf within 25 km of shore.

Annual and seasonal differences in biophysical parameters were related to early marine growth of salmon. Warmer spring temperatures and higher zooplankton biomass occurred in El Niño years 1997–1998 compared to La Niña years 1999–2000. This was particularly evident in 1999, when decreased temperature and zooplankton biomass translated into lower apparent growth during June–July for pink and chum salmon in strait habitats (Fig. 3). Lower growth rates may increase mortality by making juveniles more vulnerable to size-selective predation or by decreasing their ability to compete.

Fig. 2. Average monthly proportion of cumulative catch of juvenile salmon (standardized for effort) sampled at stations in inshore, strait, and coastal habitats, May–September, 1997–2000.

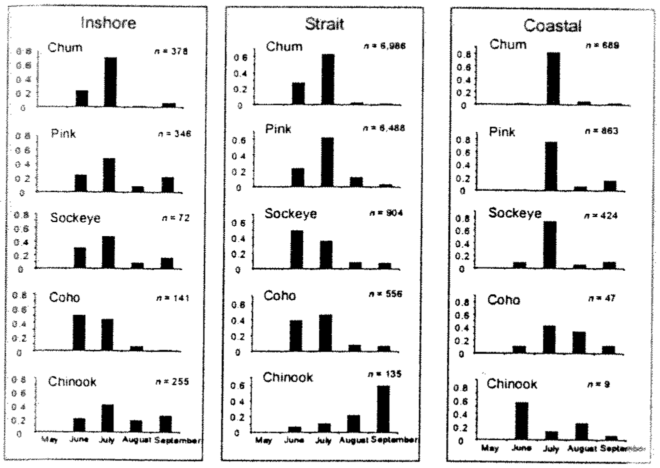
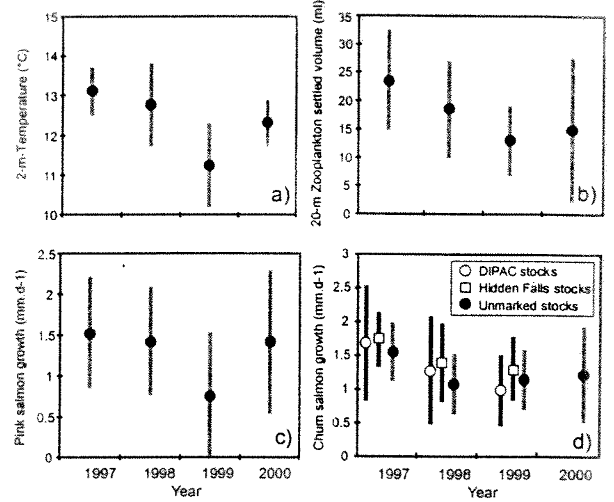


Fig. 3. Values (one SD about the mean) for: a) 2-m temperature, b) 20-m zooplankton settled volume, c) growth of juvenile pink salmon, and d) growth of juvenile chum salmon in strait habitats of Southeast Alaska, June–July, 1997–2000.



For pink salmon, early marine growth and abundance of juveniles may indicate year-class strength. Apparent growth of juvenile pink salmon in strait habitats from June–July and July–August was 1.4 and 1.3 mm.d-1 in 1998 compared to 0.8 and 0.7 mm.d-1 in 1999. Catch rates of juvenile pink salmon were also substantially higher in 1998 compared to 1999. Consequently, the harvest of adult pink salmon in Southeast Alaska was almost four times as high in 1999 (77.5 million) as in 2000 (20.2 million). Therefore, high marine survival may be predictable from high abundance of juvenile pink salmon and favorable growing conditions in strait habitats during early marine residence.

At-sea stomach analysis of potential predators indicated that predation on juvenile salmon occurred in five of the 19 fish species examined. Salmon occurred in 4% of the 876 stomachs examined. The percentage occurrence of salmon for each predator species was: 29% in age-1+ sablefish, 9% in adult coho salmon (*O. kisutch*), 8% in Pacific sandfish (*Trichodon trichodon*), 3% in spiny dogfish (*Squalus acanthias*), and < 1% in walleye pollock (*Theragra chalcogramma*). Predation on juvenile salmon by adult coho salmon and by spiny dogfish was observed in three of four years, by sablefish in two of four years, and by Pacific sandfish and walleye pollock in one of four years.

Data on origin of juvenile salmon show that fish in inshore and strait habitats are predominately of local origin, and are mixed with stocks of other regions when they enter the coastal waters of the Gulf of Alaska. Coded-wire tags were recovered from 34 (9%) juvenile chinook (*O. tshawytscha*) and 42 (4%) juvenile coho salmon. Over 90% (70) of the tagged juveniles were of Alaska origin, and were captured in inshore and strait habitats. Juveniles from the Columbia River (five chinook and one coho) were also recovered, only in coastal habitats. Marine migration rates of juvenile chinook and coho salmon averaged 1 and 3 km.d-1 for Alaska stocks, and 19 and 25 km.d-1 for Columbia River stocks. Otolith thermal marks were found in 985 (38%) of the juvenile chum and 57 (12%) of the juvenile sockeye salmon (*O. nerka*) sampled. All juvenile salmon with thermal marks were of Alaska hatchery origin, except one fish from British Columbia captured in the coastal habitat. In inshore and strait habitats in June and July, Alaska hatchery chum salmon comprised 50–100% of the total chum salmon catch; in coastal habitats, they comprised 5–35% (Fig. 4). No pink salmon were sampled for otolith marks because marking rates were low for this species.

Long-term ecological monitoring of key juvenile salmon stocks, in several regions of the North Pacific Rim and encompassing a variety of environmental conditions, is needed to understand the relations of habitat use, marine growth, and hatchery-wild stock interactions to year-class strength and ocean carrying capacity.

Fig. 4. Seasonal stock composition of juvenile chum salmon based on thermal mark recoveries in inshore, strait, and coastal habitats of Southeast Alaska, June–October, 1997–2000.