Early Marine Growth and Habitat Utilization of Two Major Southeastern Alaska Chum Salmon Stocks, Based on Thermally Marked Otoliths Recovered 1997–2000

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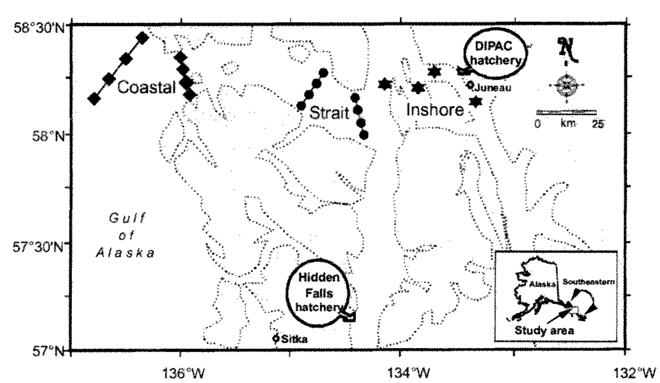
Identifying stock-specific life history characteristics of Pacific salmon (*Oncorhynchus* spp.) during their early marine residence period is critical to adequately assess interactions among biophysical parameters, marine survival, inter- and intra-specific competition, and coastal habitat utilization. The marine migration patterns and growth rates of juvenile salmon are not well documented (Walters et al. 1978). Such parameters must be derived from representative field data to establish accurate inputs for bioenergetics models (Ney 1993). These models can then be used to estimate prey consumption and growth potential of juvenile salmon and production capacity of their marine habitats.

Over the past century, chum (*O. keta*) and pink salmon (*O. gorbuscha*) have been the numerically dominant species in the commercial salmon fisheries in southeastern Alaska. Record annual harvests of chum (16 million fish) and pink salmon (78 million fish) occurred in the 1990s (ADFG 2000). From 1996 to 2000, the average annual commercial chum salmon ex-vessel value was the highest ($30 million) of any salmon species. Record abundance of salmon in the region resulted from both increased hatchery production and favorable survival conditions for wild stocks. Over 77% of the chum salmon catch in the region is now produced by hatcheries, raising questions about the maximum production capacity of the marine environment of sustain both wild and hatchery juveniles. Accurate information on stock-specific life history characteristics can contribute to a better understanding of the factors limiting production.

The development and implementation of otolith-marking technology within the last decade have enabled scientists to track the migration and growth, and hatchery managers to evaluate ocean survival and harvest rates, of specific stocks of chum salmon in southeastern Alaska (Tersteeg and Focht 1998). Douglas Island Pink and Chum (DIPAC) Hatchery, a private non-profit (PNP), began production-scale otolith thermal marking in 1990 when salmon were marked at the eyed stage, and released as fed fry the following spring (Munk et al. 1993). Since then, up to 100% of all species of salmon produced by DIPAC have been otolith thermal marked. At another PNP, Hidden Falls Hatchery, about 60% of chum salmon are released thermally marked. Between the two major hatcheries, >130 million marked juvenile chum salmon are released in the region annually.

We initiated a study in the northern region of southeastern Alaska in 1997 to determine growth and habitat utilization of seaward migrating juvenile salmon (Orsi et al. 1997). Juvenile salmon were sampled with a surface trawl 1.5–65.0 km offshore during four periods each year from June to September 1997–2000 in three geographic habitats: "inshore" waters far inside the Alexander Archipelago, "strait" waters encompassing the major inside migration corridor of the region, and "coastal" waters adjacent to and in the Gulf of Alaska (Fig.1). The catch was identified and measured at sea, and juvenile salmon were frozen. About one third of the frozen chum were later weighed, and the right sagittal otolith was removed and mounted for thermal mark identification. Two "readers" independently examined each otolith to ensure accuracy; a third reader resolved any disagreements in identification.

Fig. 1. Sampling conducted in inshore, strait, and coastal habitats of southeastern Alaska, June–September, 1997–2000. Localities of the two hatcheries (DIPAC and Hidden Falls) releasing thermally marked chum salmon are shown.



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Seasonal habitat utilization of chum salmon was described by catch per haul, and the percent composition of DIPAC, Hidden Falls, and unmarked stocks each month was pooled by years. The number of Hidden Falls fish was estimated by adjusting for the fraction marked; the estimate of unmarked stocks was the unmarked fish less the Hidden Falls adjustment. Size of chum salmon and time of release from the two facilities was derived from hatchery release information and voucher samples. Each year, a weighted mean size and time of release was computed by release group for each facility. To determine migration rates, distances were measured from seawater net pen localities to central points within each habitat. Migration rates for the two stocks were determined only for the strait and coastal habitats in July of each year, as insufficient numbers of both stocks were captured in inshore habitats.

Habitat utilization of the two major chum salmon stocks varied seasonally; most juvenile chum salmon migrated seaward through the habitats in June and July, with annual densities highest in strait habitat and lowest in inshore habitat (Fig. 2). Of the 3,823 chum salmon processed in the four-year period, 2% were from inshore habitat, 75% were from strait habitat, and 23% were from coastal habitat. Low catches in inshore habitat resulted from fish being abundant closer to shore than our gear sampled. The two hatchery stocks represented about 77%, 62%, and 28% of the juvenile chum salmon catch composition in inshore, strait, and coastal habitats, respectively. Migration rates of the two stocks, from the time of hatchery release in May until synoptic recoveries in strait and coastal habitats in July, averaged 0.9–3.6 km.d^{-1} over 60–240 km distances (Fig. 3). These recoveries indicated slower migration rates and higher relative growth rates in strait compared to coastal habitat. Condition factors were also higher for both stocks in strait ($K = 9.3$–10.3, $\bar{x} = 9.8$) compared to coastal ($K = 8.8$–9.6, $\bar{x} = 9.2$) habitat. These differences were attributed to higher temperatures and zooplankton biomass in strait habitat, and to the shorter distance to strait habitat, which allowed energy to be allocated to growth rather than migration.

We examined stock-specific growth rates in strait habitat, where adequate numbers of thermal marks from both stocks were recovered each year. Instantaneous growth rates (% body wt.d^{-1}) were generally highest in the May–June period ($\bar{x} = 4.1$), intermediate in the June–July period ($\bar{x} = 3.7$), and lowest in the July–August period ($\bar{x} = 2.3$) (Fig. 4). Annual growth rates of fish in the strait habitat during the June–July period were highest in 1997, an El Niño year coinciding with high annual temperature and zooplankton biomass. Thermal mass marking of the two major hatchery chum stocks in the region has enabled us to determine stock-specific growth and habitat utilization patterns. We plan to use this information to estimate relationships among biophysical parameters, inter- and intra-specific competition, and marine survival, and as inputs for bioenergetics models to better define the salmon production capacity of southeastern Alaska.

Fig. 2. Seasonal stock composition and abundance of juvenile chum salmon in inshore, strait, and coastal habitats of southeastern Alaska, June–September 1997–2000.

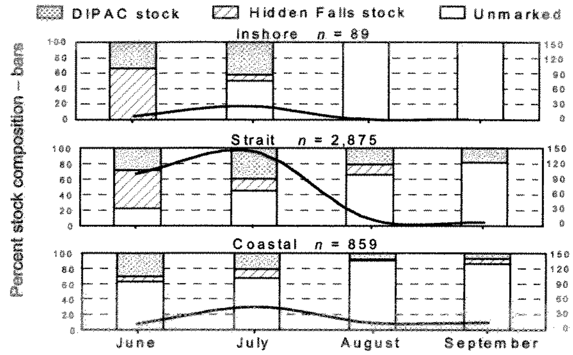


Fig. 3. Growth and migration rates of two juvenile chum salmon stocks released in May and recovered concurrently in strait and coastal habitats of southeastern Alaska in July, 1997–2000. Lines about growth rates are one standard deviation.

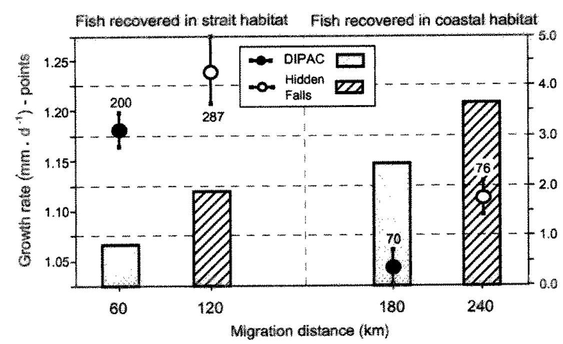
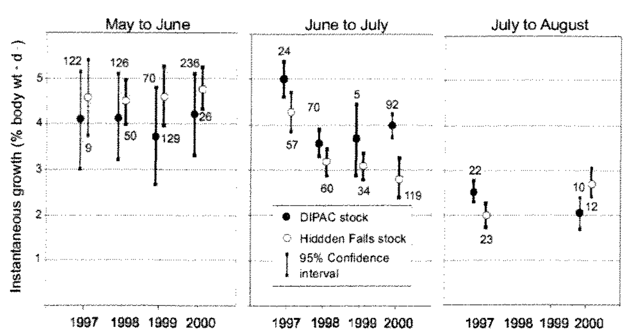


Fig. 4. Instantaneous growth rates of two juvenile chum salmon stocks at different time periods in strait habitat of southeastern Alaska, May–June, June–July, and July–August, 1997–2000.



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