Hatchery and Wild Stock Interactions of Juvenile Chum Salmon in Marine Waters of Southeastern Alaska: A Bioenergetics Approach

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As part of the Southeastern Alaska Coastal Monitoring project, the interactions of hatchery and wild stocks of juvenile chum salmon (*Oncorhynchus keta*) migrating seaward were studied in littoral (nearshore) and neritic (epipelagic offshore) marine habitats in southeastern Alaska. Bioenergetics modeling was used to estimate prey consumption by different salmon stock groups during their first five months at sea. Model runs were completed using biophysical data collected in Icy Strait, a regional salmon migration corridor, in May, June, July, August, and September of 2001 (Fig. 1). These data included: temperature (1-m surface versus surface to 20-m average), zooplankton standing crop (surface to 20-m depth versus entire water column), salmon diet (percent weight of prey type consumed), and energy densities, weight, and growth of juvenile chum salmon. Literature values were used for energy densities of salmon prey items. Known numbers of hatchery releases were used in a cohort reconstruction model to estimate total abundance of hatchery and wild chum salmon in the northern region of southeastern Alaska assuming average survival to adults, and for two different (low and high) early marine littoral mortality assumptions.

Total prey consumption was relatively insensitive to temperature differences associated with the depths potentially utilized by juvenile chum salmon. However, the magnitude and temporal pattern of total prey consumed differed dramatically between the low and high mortality assumptions (Fig. 2). Daily consumption rates from the bioenergetics model and juvenile salmon densities from Icy Strait were used to estimate amount and percentage of zooplankton standing crop consumed by hatchery and wild chum salmon (Table 1). We estimated that only a small percentage of the available zooplankton was consumed by juvenile chum salmon, even during peak abundances of hatchery and wild fish in July (Fig. 3). Under the modeling assumptions, these results indicate that current levels of hatchery production in southeastern Alaska do not represent a significant impact on the prey resource available to wild chum salmon stocks in neritic marine habitats represented by the Icy Strait migration corridor. As with any modeling exercise, model outputs can be misleading if input parameters and underlying assumptions are not valid; therefore, additional studies are warranted, especially to refine physiological input parameters specific to juvenile chum salmon.

Fig. 1. Habitats sampled within the Icy Strait study area (northern region of southeastern Alaska), from May to September 2001. Three primary chum salmon hatcheries in the region are identified (Macaulay, Hidden Falls, and Gunnuk Creek). Principal migration routes to the Gulf of Alaska are indicated with dashed lines.

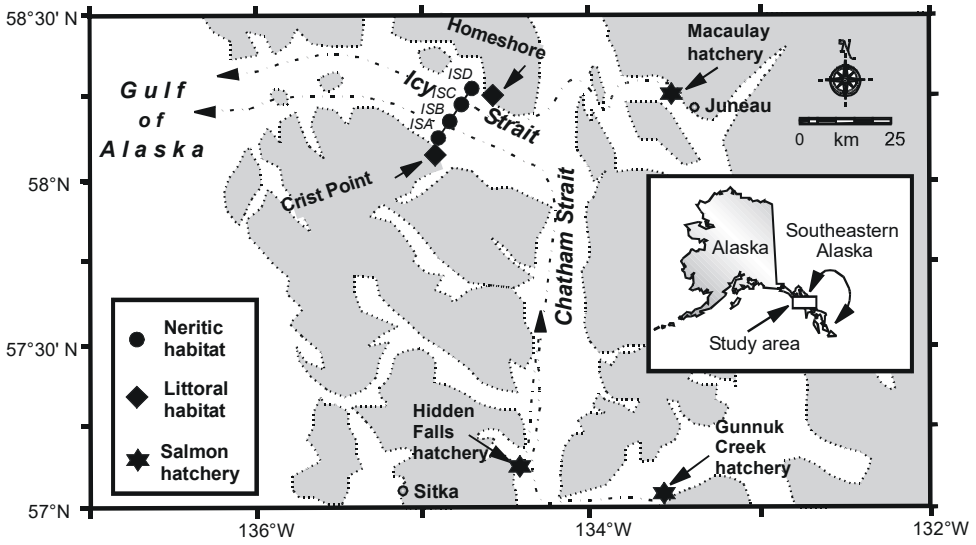

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Fig. 2. Total zooplankton consumption estimated for wild and hatchery stocks of chum salmon, based on bioenergetics model runs of two simulated early littoral mortality rates and two neritic thermal conditions in the northern region of southeastern Alaska, May to September, 2001.

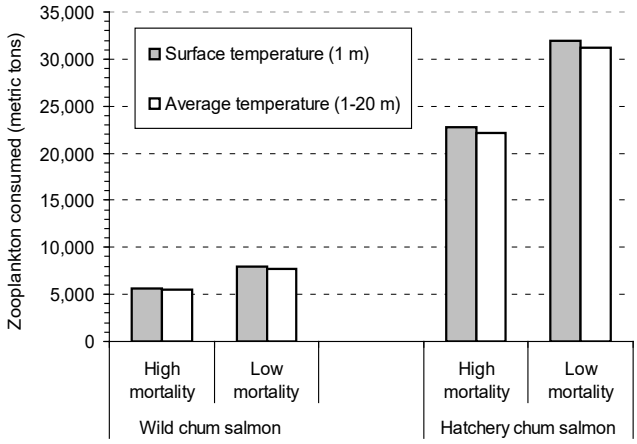

Fig. 3. Estimates of zooplankton standing crop and consumption by juvenile chum salmon in the neritic habitat of Icy Strait, Alaska, for June, July, August, and September, 2001. Panel a) shows two estimates of zooplankton standing crop at two different sampling depths, overlaid by juvenile chum salmon density estimates. Panel b) shows the percentage of available zooplankton consumed by unmarked and hatchery stocks of chum salmon for the two estimates of zooplankton standing crop. Detailed stock-specific consumption rates are shown in **Table 1**.

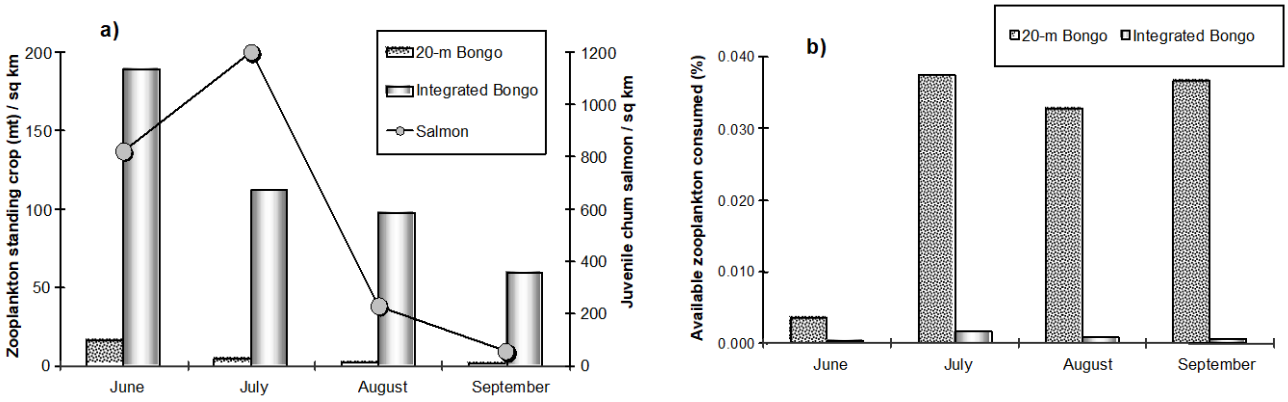

Table 1. Stock-specific estimates of zooplankton consumption by juvenile chum salmon in the neritic habitat of Icy Strait in June to September, 2001. Stock-specific consumption rates are from model runs. Total weight of juvenile chum salmon stock groups is based on stock compositions, date-specific weights, and salmon density estimates. Total consumption of zooplankton by juvenile stock groups is based on the stock-specific consumption of the total weight of the stock groups. The abbreviations for chum salmon stocks are: unmarked (UM), Macaulay hatchery (MC), and Hidden Falls hatchery (HF).

Neritic period	Stock-specific consumption (g prey/g predator · d^{-1})			Total wt of juvenile chum salmon stock groups (g/km^2)			Total consumption of zooplankton by juvenile stock groups (g/$km^2 \cdot d^{-1}$)		
	UM	MC	HF	UM	MC	HF	UM	MC	HF
Late June	0.0746	0.0909	0.0652	2,843	4,322	0	211.5	393.1	0.0
Late July	0.0843	0.0867	0.1048	13,240	1,112	5,253	1,116.2	96.3	550.3
Late August	0.0964	0.0837	0.0963	7,391	503	678	712.8	42.1	65.3
Late Sept.	0.0701	0.0628	0.0702	4,514	0	190	316.5	0.0	13.3
Total	---	---	---	---	---	---	2,356.9	531.5	628.9