North Pacific Research Board: Format for Semiannual Progress Reports

Project #: R0327

Title: Early marine ecology of juvenile chum salmon (*Oncorhynchus keta*) in Kuskokwim Bay, Alaska

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Project Summary: This project examines the early marine ecology of chum salmon in Kuskokwim Bay, Alaska. Our goal is to assess the effect of physical and biological environmental factors on feeding, condition, and growth of juvenile chum salmon in Kuskokwim Bay. Using a bioenergetically-based food web model coupled with directed sampling for prey and diet composition, growth, size structure, and energy content will help us to understand patterns observed in feeding, growth and condition of chum salmon juveniles. Specifically, our objectives include (1) determining the spatial and seasonal distribution of chum salmon juveniles throughout Kuskokwim Bay, (2) assessing the spatial and seasonal patterns of environmental variables, and (3) describing the relationship between juvenile distribution patterns and these variables. In addition, we will (4) describe food habits, (5) analyze length, weight, condition, (6) diurnal feeding patterns, and (7) growth of chum salmon. Finally, (8) we will model the bioenergetics and growth of chum salmon juveniles in Kuskokwim Bay.

Progress Summary:

To date, all juvenile chum salmon diet and energy data have been statistically analyzed. Juvenile chum salmon feeding varied with sampling year, fish size, season, and salinity. Numerical and weight-based feeding intensity increased significantly with juvenile size and season, with lowest values for juveniles collected early in the season (Table 1). Prey composition was similar between the two years of our study. Primary prey items in the juvenile diet were calanoid and harpacticoid copepods, and drift insects. Calanoid copepods and insects made up made up the majority of chum salmon diet in terms of number, > 50%, and in terms of wet weight, > 80%.

Energy density of chum salmon juveniles declined with fish size. As juvenile chum salmon increased in size from 30-39 mm fork length (FL) to ≥ 60 mm FL, their energy density significantly decreased (Figure 2). In 2004, energy density also significantly decreased with season, from 5371 cal/g in mid-May to 4932 cal/g in mid-June (Figure 3). Energy densities not only decreased with increasing month and size class, but also decreased significantly within all size classes, except the ≥ 60 mm class, from May to June. The 0-4 salinity range had significantly higher energy density than the 15-19 salinity range, but no clear pattern was evident. A decrease in energy content by sampling month and increasing fish size might suggest that juvenile chum salmon were allocating the majority of there energy into growth, not lipid storage. Decreasing energy content from May to June within size classes might be an indication that

juvenile chum salmon entering estuaries later in the season were experiencing higher energetic demands than those entering earlier, possibly due to the elevated sea surface temperatures in June. This increased energetic demand might have an impact on the overall survival probability for chum salmon juveniles in Kuskokwim Bay.

Analysis of otolith microstructure and microchemistry to determine duration of residence in Kuskokwim Bay is currently ongoing. Data analysis and report preparation of all aspects of the study is ongoing. Results concerning feeding ecology will be reported and discussed in two chapters as part of a thesis to be submitted to the University of Alaska Fairbanks (UAF), School of Fisheries and Ocean Sciences (SFOS). A poster concerning the distribution of sticklebacks has been prepared for presentation at the Fifth International Stickleback Conference to be held in Anchorage in August 2006.

Publications: (through June 30, 2006)

Burril, S., N. Hillgruber, and C. E. Zimmermann (*in press*). Estuarine ecology of juvenile chum salmon (*Oncorhynchus keta*) in Kuskokwim Bay, Alaska. Proceedings of the 22nd Northeast Pacific Pink & Chum Salmon Workshop, Ketchikan, Alaska.

Zimmerman, C.E., N. Hillgruber, S.E. Burril, M.A. St. Peters, and J.D. Wetzel. (2005). Offshore marine observation of willow ptarmigan (*Lagopus lagopus*) including water landings, Kuskokwim Bay, Alaska. The Wilson Bulletin 117(1): 12-14.

Presentations: (through June 30, 2006)

Burril, S., N. Hillgruber, and C.E. Zimmerman (2005). Estuarine ecology of juvenile chum salmon (*Oncorhynchus keta*) in Kuskokwim Bay, Alaska. Pink and Chum Salmon Workshop. Ketchikan, Alaska, February 2005.

Hillgruber, N., C. E. Zimmerman, and S. E. Burril (2005).Timing of outmigration and distribution during estuarine residence of juvenile chum salmon (*Oncorhynchus keta*) in Kuskokwim Bay, Alaska. 29th Annual Larval Fish Conference. July 11-14, 2005, Barcelona, Spain.

Hillgruber, N., C. E. Zimmerman, and S. E. Burril (2005).Timing of outmigration and distribution during estuarine residence of juvenile chum salmon (*Oncorhynchus keta*) in Kuskokwim Bay, Alaska. 135th Annual Meeting, American Fisheries Society, September 2005, Anchorage, Alaska.

Hillgruber, N., S. E. Burril, C. E. Zimmerman, and L. J. Haldorson (2006). Estuarine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska. Juneau Center, SFOS UAF Friday Seminar Series, February 24, 2006.

Hillgruber, N., C. E. Zimmerman, S. E. Burril, and L. J. Haldorson (2006). Estuarine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska. UAF Student Chapter of the American Fisheries Society, University of Alaska Fairbanks, Fairbanks, Alaska. February 2, 2006.

Zimmerman, C. E., N. Hillgruber, S. Burril, and L. J. Haldorson (2006). Estuarine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska. Marine Science in Alaska: 2006 Symposium. January 2006, Anchorage, Alaska.

Table 1. Mean total weight and number of prey items per juvenile chum salmon gut by sampling year and size class. Standard errors are shown in parentheses. n = sample size

Year	n	Mean Total Prey Weight (g)	Mean Total Prey #
2003	54	0.029 (0.003)	116 (23.71)
2004	311	0.026 (0.001)	154 (11.28)
Size Class			
2003			
40-49	29	0.024 (0.003)	85 (22.22)
50-59	25	0.033 (0.004)	160 (43.68)
2004			
30-39	89	0.011 (0.007)	65 (10.79)
40-49	156	0.027 (0.001)	133 (14.22)
50-59	63	0.042 (0.003)	215 (30.73)
60-69	3	0.085 (0.016)	838 (79.69)

Table 2. Percent body weight feeding rate (%BW), percent stomach fullness, and percent empty stomachs of juvenile chum salmon for years 2003 and 2004 and size class. Values in parenthesis represent standard errors of the mean. n = sample size.

Year	n	%BW	%Fullness	%Empty Stomachs
2003	54	3.0% (0.003)	50%	43%
2004	358	3.8% (0.001)	50%	19%
Size Class (mm)				
2003				
40-49	29	2.1% (0.003)	50%	45%
50-59	25	3.5% (0.005)	50%	40%
2004				
30-39	111	3.4% (0.002)	50%	26%
40-49	173	4.1% (0.002)	50%	18%
50-59	71	3.7% (0.002)	50%	10%
60-69	3	4.6% (0.013)	100%	0%

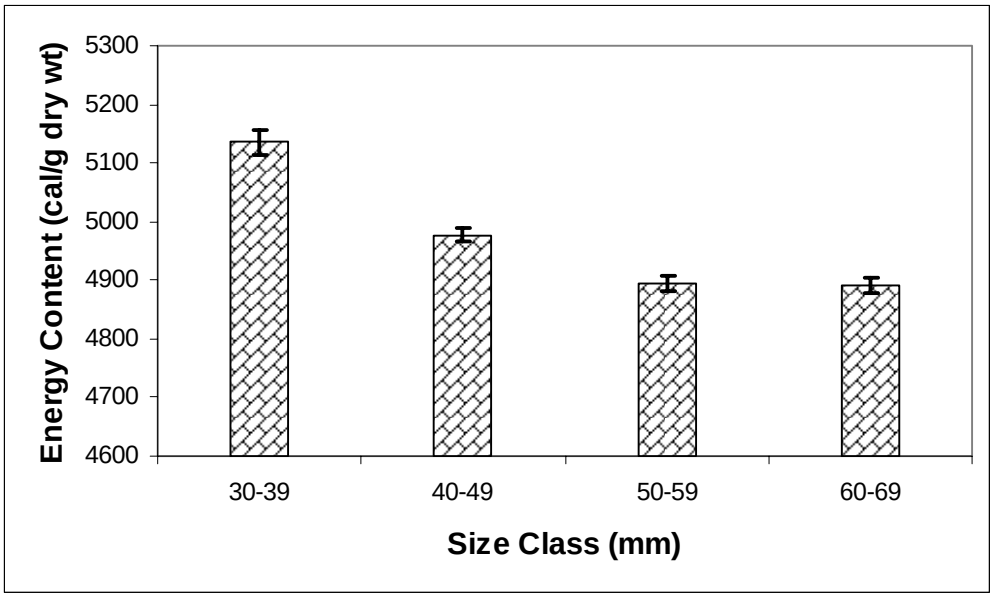

Figure 1. Comparison of energy content between juvenile chum salmon of different size classes from Kuskokwim Bay, 2004. Error bars represent ± 1 S.E. about the mean. Sample sizes are 90, 132, 66, and 3 for the 30-39 mm through 60-69 mm size classes.

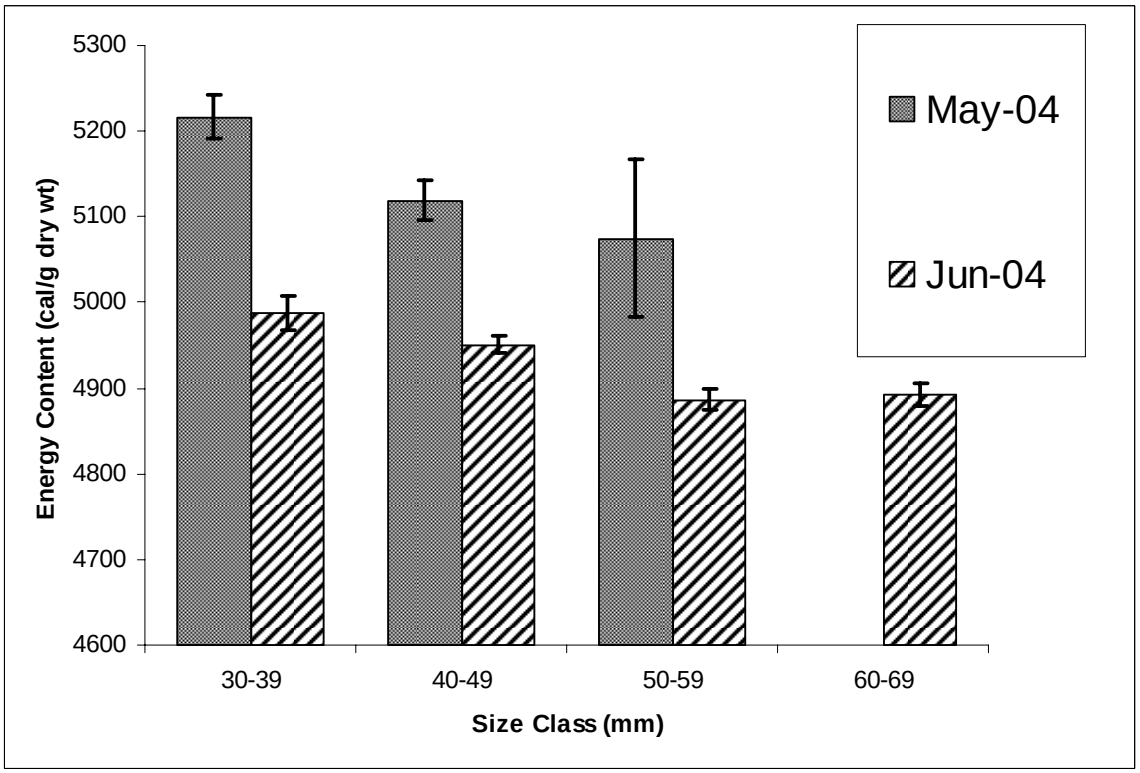

Figure 2. Comparison of energy content between juvenile chum salmon of different size classes from Kuskokwim Bay. Error bars represent ± 1 S.E. about the mean. Sample sizes are 58, 21, and 3 for the 30-39 mm thru 50-59 mm size classes in May, and 32, 11, 63, 3 for the 30-39 mm thru 60-69 mm size classes in June.