Forecasting Pink Salmon Abundance in Southeast Alaska From Juvenile Salmon Abundance and Associated Environmental Parameters

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Executive Summary

The Northern Fund project "Forecasting Pink Salmon Abundance In Southeast Alaska From Juvenile Salmon Abundance And Associated Environmental Parameters" had four specific objectives: (1) Develop a forecasting model using juvenile pink salmon catch per unit effort (CPUE) data and environmental data to predict subsequent year-class abundance; (2) Determine if there is regional concordance in relative abundance and growth of juvenile pink and chum salmon between northern and southern areas of Southeast AK; (3) Use a bioenergetic model to estimate daily prey consumption rates of juvenile pink and chum salmon to determine the proportion of zooplankton standing crop consumed; and (4) Compare total prey consumption of juvenile pink salmon with total prey consumption of hatchery and wild juvenile chum salmon in strait habitats of northern and southern areas of Southeast AK.

For Objective 1, a four-step process has been developed to evaluate forecast models from an index of juvenile pink salmon abundance and associated environmental data. The index of juvenile abundance is significantly correlated with the subsequent year's harvest. Forecast models using juvenile CPUE provided accurate forecasts for 2004, 2005, and 2007. However, the harvest was only 30% of the forecast in 2006, when the return was the weakest since 1988. Incorporation of the juvenile CPUE data still improved forecasting models for 2006 by indicating a lower return than alternative methods. Forecast models for 2008 indicate a poor return for SEAK pink salmon, based on low juvenile salmon catches in the summer of 2007. Incorporation of June temperature and EL Nino Southern Oscillation (ENSO) data into the forecast models showed promise of improving forecast accuracy; "jackknife" results indicated that the 2006 forecast have been much better if the ENSO index was part of the model. The three sub-objectives of Objective 1 were effectively met. Geographic scope of the projected harvest did not greatly affect the performance of the forecast models; incorporation of escapement index data to create a total run index did not improve the forecast model; and bootstrap regression techniques were developed to incorporate measurement error into the forecast models.

For Objective 2, abundance patterns in the northern and southern areas for both juvenile pink and chum salmon were generally in concordance, but differences between species were observed in terms of relative abundance between areas, and strength of the juvenile year classes. Juvenile pink salmon were generally more abundant in the southern area, but the intra- and interannual patterns of abundance were the same for both areas; abundance was highest in 2006 and lowest in 2007. Juvenile chum salmon did not differ consistently in abundance between the northern and southern areas. For chum salmon, abundance was highest in 2005, and lowest in 2007. Growth rates and fish size varied between areas, with no consistent trends for either species over the three year sampling period.

For Objectives 3 and 4, consumption rates of juvenile salmon in 2005 were consistently higher in the 3- m surface temperature simulation than the 20 m integrated temperature simulation. This finding was consistent for each species and stock group and in each

sampling period. The warmer simulation increased rates and thus total consumption of the species and stock groups by about 5-12% in each area and time period. Zooplankton consumption by juvenile salmon was lower in both areas during July than in June due to the lower densities of both species and lower consumption rates in July. Juvenile pink salmon consumed more prey than juvenile chum salmon in the southern area, and less than juvenile chum salmon in the northern area. Hatchery chum salmon consumed a larger proportion of the total chum salmon consumption in both northern and southern areas. Trophic demand, estimated as the percentage of the zooplankton standing crop consumed, was low for both species. The highest trophic demand, combined for both pink and chum salmon juveniles, was 0.1% (zooplankton/km^2) in the southern area during June

1 INTRODUCTION

In 2005, the Northern Fund Committee of the Pacific Salmon Commission approved funding for this project to collect information on juvenile salmon and associated biophysical parameters in the marine environment of Southeast Alaska. The principle objectives of the project were to determine the feasibility of using such information for forecasting pink salmon abundance and to increase understanding of the trophic relationships and ecological interactions of wild and hatchery juvenile salmon. Reliable forecasting tools allow fishery managers, fishermen, and processors to plan harvest strategies that ensure conservation, equitable allocation, and prudent economic utilization of salmon resources. This project specifically addresses the 2004 Fund Committee call for projects 1.d, "Development and/or implementation of techniques to improve …forecasting". The forecasts will be based on relative abundance and size of juvenile pink salmon and associated environmental variables in the sampling area measured a year prior to their adult cohort return.

Because of poor pre-season forecasting success and large uncertainty in estimating escapement numbers, the Alaska Department of Fish and Game (ADFG) no longer uses a spawner/recruit approach to forecast Southeast Alaska pink salmon, but instead predicts future harvests from the time series of prior harvest using an exponential smoothing model (Plotnick and Eggers 2004; Eggers 2005). Mortality of juvenile pink salmon is high and variable during their initial marine residency, and is thought to be a major determinant of year-class strength (Parker 1968; Mortensen et al. 2000; Willette et al. 2001). Sampling juveniles after the period of high initial mortality may provide information that can be used with associated environmental data to forecast abundance. The Southeast Coastal Monitoring Project (SECM) of the Auke Bay Laboratory has sampled juvenile salmon using a large rope-trawl in the northern area of Southeast Alaska for the past eight years. Wertheimer et al. (2006) found that abundance of juvenile pink salmon from 1997 to 2003 in the strait habitats sampled by SECM was highly correlated with the subsequent year's catch in Southeast Alaska, and had promise as a forecast tool for pink salmon. This report examines the efficacy of using indexes of abundance of juvenile pink salmon in Southeast Alaska to forecast pink salmon returns to Southeast Alaska in subsequent years.

This project contributes to one of the general goals and guiding principals of the Northern Fund under the 1999 Pacific Salmon Agreement, "...improved scientific understanding of limiting factors affecting salmon production in the … marine environment." Ocean production of salmon in terms of numbers of fish is closely linked with their early ocean survival. This project will explicitly evaluate relationships between biophysical conditions encountered by juvenile salmon, environmental data sets, and growth and abundance of Southeast Alaska pink salmon. This information will provide insight into trophic relationships, carrying capacity, hatchery and wild stock interactions, and the potential for density-dependent interactions in the coastal ocean. Such data series are essential to understand how cyclical environmental changes (e.g., regime shifts) and short-term climatic events (e.g., El Niňo) affect salmon ecology and marine production.

2 OBJECTIVES

The project has four specific objectives:

(1) Develop a forecasting model using juvenile pink salmon catch data and environmental data to forecast subsequent year-class abundance.

(2) Determine if there is regional concordance in relative abundance and growth of juvenile pink and chum salmon between northern and southern areas of Southeast AK.

(3) Use a bioenergetic model to estimate daily prey consumption rates of juvenile pink salmon to determine the proportion of zooplankton standing crop consumed.

(4) Compare total prey consumption of juvenile pink salmon with total prey consumption of hatchery and wild juvenile chum salmon in strait habitats of northern and southern areas of Southeast AK.

3 METHODS

3.1 Data Collection

Two transects with four stations each were sampled in the northern and southern areas of Southeast Alaska in both June and July of 2005, 2006, and 2007 (Figure 1). Fish sampling was accomplished with a Nordic 264 rope trawl modified to fish the surface water directly astern of the *John N. Cobb*, a 28-m NOAA fisheries research vessel. Oceanographic data were collected at each station immediately before or after each trawl haul, and consisted of one conductivity-temperature-depth profiler (CTD) cast, one vertical plankton haul with a conical net, and a pair of double oblique plankton hauls with a bongo net system.

After each trawl haul, the fish were anesthetized with tricaine methanesulfonate (MS-222), identified, enumerated, measured, labeled, bagged, and frozen. Samples of juvenile pink and chum salmon were also preserved in 10% formalin-seawater solution for diet analysis. Frozen individual juvenile salmon were weighed in the laboratory to the nearest 0.1 gram (g). Mean lengths, weights, and length-weight residuals were computed for each species by habitat and sampling interval. Apparent growth rates in mm/d for each area and year were calculated as the slope of the regression of size as a function of sampling date. The regression equations were then used to estimate average size of juvenile salmon on a common date (July 24).

To identify stock of origin of juvenile chum salmon, the sagittal otoliths were extracted from the crania of frozen samples and preserved in 95% ethyl alcohol. Laboratory processing of otoliths for thermal marks was contracted to Douglas Island Pink and Chum (DIPAC). Stock composition and growth trajectories of thermally marked fish were then determined for each month and habitat.

Fish preserved for diet analysis were evaluated for stomach fullness, total content weight, and taxonomic composition by number and weight. Zooplankton samples were analyzed in the laboratory for zooplankton settled volumes (SV, ml) and total settled volumes (TSV, ml) of each 20-m vertical zooplankton haul. Displacement volumes (DV, ml) of zooplankton were measured for bongo net samples (333-µm and 505-µm mesh) collected in Icy Strait and Lower Clarence Strait. Detailed zooplankton species composition of these hauls was determined microscopically from subsamples obtained using a Folsom splitter. Percent total composition was summarized by major taxa, including small calanoid copepods (≤ 2.5 mm TL), large calanoid copepods (> 2.5 mm TL), euphausiids (principally larval and juvenile stages), oikopleurans (Larvacea), decapod larvae, amphipods, chaetognaths, and combined minor taxa. More detailed methods for field sampling and laboratory processing have been reported in North Pacific Anadromous Fisheries Commission (NPAFC) Document 955 (Orsi et al. 2006) and Document 1057 (Orsi et al. 2007).

The whole body energy content (WBEC) for juvenile chum salmon and pink salmon used in the model was estimated by bomb calorimetry from frozen samples each month. In most cases, these samples were taken at the same time fish were preserved for diet analysis. Juvenile salmon were combusted in a Parr 1425 Semimicro Bomb Calorimeter. For bomb calorimetry, individual whole fish minus their otoliths and stomach contents were dried to constant weight, homogenized in a grinder, and subsamples were generally pressed into 0.15 g pellets for combustion. Percent dry weight (DW) was calculated, and cal/g DW was converted to Joules/g (J/g) wet weight for individual specimen values. WBEC values (J/g wet wt) from single pellets were used because quality control tests showed no statistically significant difference among multiple pellets from an individual fish.

3.2 Forecasting

For the forecasting component of the project, we examined three measures of juvenile pink salmon CPUE at the northern straits stations (Icy Strait and Upper Chatham Strait), three measures of juvenile pink salmon growth and condition, two measures of zooplankton standing crop, and nine measures of physical conditions that could affect pink salmon growth and survival. These parameters were evaluated for bivariate correlation with the annual commercial harvest of pink salmon in Southeast Alaska. The three measures of juvenile CPUE were 1) Peak CPUE, the average Ln (CPUE+1) for catches during the month that had the highest average catches in a given year; 2) JJ-Avg (CPUE), the mean of the average Ln (CPUE+1) for June and July; and 3) JJA-Avg (CPUE), the mean of the average Ln (CPUE+1) for June, July, and August. The two measures of zooplankton were May and June average NORPAC 20-m SV as an index of upper water column zooplankton; and May and June average 333-bongo DV as an index of zooplankton to 200-m depth. Seven of the physical parameters were measures of conditions occurring during the SECM sampling in Northern SEAK: May 3-m water temperature; May upper 20-m average water temperature; July 3-m average water temperature: June upper 20-m average water temperature; May/June/July average 3-m water temperature; mixed-layer depth (MDL) in June; and July 3-m salinity. The other two physical parameters were indices of factors that affect the Gulf of Alaska and the North Pacific Ocean: the annual November to March average of Pacific Decadal Oscillation (PDO) during the winter prior to the juvenile pink salmon rearing period (Mantua et al. 1997); and the annual average multivariate El Nino Southern Oscillation (ENSO) index occurring in the calendar year prior to the entry of juvenile pink salmon into the ocean (NCDC 2007). We obtained associated pink salmon harvest data from the Alaska Department of Fish and Game (ADFG 2007).

We used a four step process to identify the forecast model for predicting pink salmon harvest in SEAK. The first step was to develop a regression model of harvest and juvenile salmon CPUE, with physical conditions, zooplankton volumes, and pink salmon growth indices considered as additional parameters. The potential model was

$$\mathrm{Ln(Harvest)} = \alpha + \beta(\mathrm{Ln(CPUE)}) + \gamma_1 X_1 + ... + \gamma_n X_n + \varepsilon$$

where γ is the coefficient for environmental variable X. Backward/forward stepwise regression with an alpha value of $P < 0.1$ was used to determine whether an environmental variable was added or retained in the model.

The second step was to calculate the Akiake Information Criterion (AIC) for each significant step of the stepwise regression, to prevent over parameterization. The AIC was corrected (AIC_c) for small sample sizes (Shono 2000).

The third step was a jackknife approach to evaluate "hindcast" forecast accuracy over the entire SECM time series. This procedure generates forecast model parameters excluding a year of data, then uses the excluded year to "forecast" harvest for the associated harvest year; this process is repeated so that each year in the time series is excluded and used to generate a forecast. The average relative forecast error is then calculated for each model.

The final step was to compare bootstrap confidence intervals with the regression prediction intervals for the forecasts. The bootstrap approach is described below for sub-objective 1. The bootstrap prediction intervals provided a check on the effect of measurement error as the number of parameters in the model increased.

Three sub-objectives were identified for the forecasting component of the project: (A) geographic scope of the forecasts; (B) uncertainty due to measurement error; and (C) consideration of escapement magnitudes for indexing total return.

Sub-objective 1.A was addressed by comparing CPUE models using total Southeast Alaska (SEAK) harvest as the dependent variable with models considering only the Northern Southeast Inside (NSEI) harvest as the dependent variable. The jackknife procedure was used to compare relative forecast error between the geographic locales.

Sub-objective 1.B was addressed by developing bootstrap confidence intervals (CI) for each forecast model. We randomly resampled juvenile catches for each month in each year *y* n_{my} times, where *n* is the number of hauls in month *m* in year *y*, and then we averaged the resampled catches for each month and year. For example, average simulated catches for years 1997-2005 were used to construct the regression models with SEAK harvest as the dependent variable, and the appropriate averages of the simulated catches for 2006 were used to forecast 2007 harvests. This process was repeated 1000 times, generating 1000 forecasts for each model. The forecasts were ordered from lowest to highest, and the lowest 10% and highest 10% were removed to define the 80% bootstrap CIs. These results were then compared to the prediction CIs for the regression model based on the observed annual average catches.

Sub-objective 1.C was addressed by generating an index of total run by using the average ratio of catch to peak escapement over the time series as a scalar to weight peak escapement counts. The annual peak escapement count multiplied by the scalar was added to harvest data to generate the total run index. This parameter was then used as the dependent variable in the forecast models to examine the sensitivity of the models to variation in the harvest:escapement index ratio.

3.3 Bioenergetic Analysis

3.3.1 Bioenergetics model and input parameters

We used the Wisconsin Bioenergetics Model 3.0 (Hanson et al. 1997) to estimate the consumption of zooplankton by hatchery and unmarked stocks of juvenile chum salmon and juvenile pink salmon in migration corridors of the northern and southern areas of SEAK. In each area, we estimated consumption by species and stock groups at two different time periods in 2005, late June and late July. For chum salmon, stock-specific information was available for marked hatchery stocks in each area, so it was possible to use representative stock groups to calculate consumption in each area. For pink salmon, no specific stock groups were used, so the unmarked component was assumed to represent a mixture of wild stocks throughout the region. Biophysical input parameters measured in each area and time period included: calendar date (Julian), water temperature (two scenarios: 3 m and upper 20 m integrated), zooplankton standing crop (two BONGO net mesh sizes), salmon abundance (fish/km2 and fish/km3), salmon weights (g), salmon diet (proportion of each prey category by weight), energy densities (prey categories and juvenile salmon: J/g wet wt), and standard physiological values (model). Input parameters for each of the field data collections (i.e., temperatures and salmon catches) were averaged from all the available trawl hauls representing an area and time period. Zooplankton measurements were taken four times in each area and time period and averaged by each mesh size. Input parameters from laboratory analysis were represented by sub- samples for each species and stock group (i.e., salmon energy density and diet).

The first set of model runs compared the effect of temperature on zooplankton consumption by juvenile salmon using temperature data collected with juvenile salmon at sea. Two different simulations of thermal experience were chosen to model consumption: temperatures at near-surface and temperatures integrated over the upper water column. In the near-surface simulations, temperatures were taken from the vessel intake at a 3-m depth. For the upper water column integrated simulation, measurements were averaged for 1-m depth increments down to 20 m. These two simulations were used to determine the effect of temperate on zooplankton consumption rates by the different species and hatchery stock groups of salmon in each area and time period.

The second set of model runs compared the magnitude of zooplankton consumed by juvenile salmon to the available standing stock of zooplankton. The zooplankton consumption estimated for each species and stock groups in the initial set of model runs was divided by the available zooplankton standing stock estimated from the plankton net samples. This proportion was calculated using the two different plankton net mesh sizes and two different metrics of fish density (g/km^2 and g/m^3).

3.3.2 Estimation of juvenile salmon numbers.

We used trawl catches and area swept to directly estimate numbers of salmon in Icy Strait and Clarence Strait for species- and locality-specific point estimates of daily consumption. These consumptions were then used to estimate the proportion on zooplankton standing crop consumed in each area and time period. Average catch of fish per unit effort (CPUE, where E = one trawl haul) was calculated for juvenile chum and pink salmon during trawling operations. Catchability was assumed to be 1. Mean density of juvenile salmon · km^{-2} was based on a trawl area swept of 36,000 m^2, which is 0.036 km^2. The number of salmon per km^2 in each habitat ($Nkm2_{Si}$) at each time period *i* was calculated as:

$$Nkm2_{Si} = CPUE_i / 0.036 .$$

Mean density of juvenile salmon · m^{-3} was based on a trawl swept area of 648,000 m^3. The number of salmon per m^3 in each habitat ($Nm3_{Si}$) at each time period *i* was calculated as:

$$Nm3_{Si} = CPUE_i / 684{,}000 .$$

Stock-specific proportions were applied to chum salmon CPUE to determine stock-specific densities. All pink salmon were considered unmarked and to have originated from wild stocks.

4 RESULTS

Two transects with four stations each were successfully sampled in the northern and southern areas of Southeast Alaska in both June and July of 2005, 2006, and 2007 (Figure 1). The addition of the southern stations to the SECM sampling cruises was a direct result of the Northern Fund support for this project. Detailed summaries for SECM sampling and initial laboratory processing are reported for 2005 in Orsi et al. (2006) and for 2006 in Orsi et al. (2007). Detailed summaries for the 2007 season will be presented in an NPAFC document in September, 2008. Analyses and results pertinent to the four objectives of this project are presented below.

4.1 Objective 1: Forecasting

4.1.1 Forecasts for 2004-2007

Comparisons of the forecasts to actual returns for 2004-2006 indicated that the Peak CPUE for June and July is the best predictor of the three CPUE parameters evaluated (Table 1). For all three years, this measure of CPUE had the lowest deviation of actual harvest from the predicted harvest. For this reason, subsequent model development for the 2007 and 2008 forecasts used only this measure of CPUE.

For all the forecast models evaluated, the actual harvests in 2004, 2005, and 2007 were within the 80% prediction confidence intervals, and were generally within 15% of the actual harvest. The Peak CPUE forecasts deviated from the estimated actual harvests in 2004 and 2005 by 0.2% and 3.8%, and from the JJ-Avg forecast by 9.7% and 10.3%, respectively. The ADFG model also performed well for 2004 and 2005, deviating from the actual harvests by 10.4% and 17.2% respectively (Table 1).

In contrast, forecast performance for 2006 was poor for all models, overestimating harvest by 200% to 370% (Table 1). Pink salmon harvests in SEAK in 2006 were very poor; preliminary estimates are about 11.4 million fish, the lowest harvest since 1988. The harvest was well below the lower end of the 80% CIs of the predictions for the juvenile CPUE models and the ADFG exponential smoothing forecast model (Table 1).

The 2006 forecast models included evaluation of the effect of high catches of juvenile pink salmon in August of 2005 in northern strait habitat. Because August catches in prior years were low, we had assumed that most juvenile pink salmon had migrated from the northern strait habitat by August, and we had not considered August CPUE for the forecasting models. The anomalous August catches in 2005 may have been due to high near-surface water temperatures affecting juvenile salmon distribution; average water temperatures for May and June in 2005 were the highest for those months during11 years of SECM sampling for that time period, and the May-June-July average temperature was also the highest it has been for the SECM time series (Figure 2). We evaluated the effect of the high August catches on the prediction models by (1) incorporation of August catches into a seasonal average for each year, JJA-CPUE; and (2) developing forecasts using the Peak CPUE model with and without inclusion of the August peak catches.

Incorporating the high August catches in 2005 in the predictor variable did not improve the forecast, but instead resulted in a greater overestimate of return. The poor performance of the CPUE predictions using the high August juvenile samples suggested that the anomalous distribution of juvenile pink salmon in 2005 may have been indicated adverse conditions associated with poor survival, rather than high annual abundance. Drought conditions and high stream temperatures in the late summer and fall of 2004 may have contributed to the poor year class strength of pink salmon in 2006. However, the juvenile CPUE should, conceptually, account for low recruitment of pink salmon from streams to the coastal marine environment. Return rates of pink salmon to the one large pink salmon hatchery in Southeast Alaska were 0.6%, well below the average return of 2.8% over the past 19 years (personal communication, Sam Raebung, Armstrong-Keta Inc., Juneau, AK), indicating that poor marine survival as well as adverse freshwater conditions affected the 2006 returns. The poor performance of the CPUE models in 2006 may indicate that variable overwinter mortality after migration from the inside coastal waters affected year-class strength (Beamish and Mahnken 2001; Moss et al. 2005). Periodic high mortality events at this stage would not be reflected by the juvenile CPUE in the strait habitat.

In 2007, we identified a two-parameter model, incorporating both juvenile CPUE and May temperature data, as the "best" linear forecast model. In 2007, ADF&G also incorporated the Peak CPUE data into their exponential smoothing model (Eggers 2007). The multiple regression model had a forecast deviation of -10%, slightly better than the -12% deviation for the simple regression model (Table 1). The ADF&G forecast was greatly improved by incorporating the juvenile CPUE data into the model: forecast deviation declined from 30% without the juvenile data to 7% for the adjusted forecast.

4.1.2 Forecasts for 2008

To forecast 2008 returns, we evaluated Peak CPUE models incorporating 2006 juvenile CPUE data, associated biophysical parameters, and 2007 harvest data. We also considered August CPUE as an auxillary model parameter that could indicate delayed migration or anomalous distribution.

Bivariate correlations of harvest with juvenile CPUE data and other biophysical parameters are shown in Table 2. Peak CPUE (excluding August) was highly ($r = 0.89$) and significantly ($P = 0.001$) correlated with SEAK pink salmon harvest. None of the other parameters evaluated were significantly correlated with harvest.

In the stepwise regression analysis, a four-parameter model including CPUE, June 20-m temperature, ENSO, and July 3-m salinity explained 99% of the variability in the harvest data (Adjusted R^2), as compared to 80% for the simple linear regression with Peak CPUE (Table 3, SEAK Harvest Area). The two-parameter model included May temperatures, similar to the 2007 forecast model, and increased the adjusted R^2 to 93%. When ENSO entered the model, May temperatures were replaced by June temperatures. The AIC_c decreased at each model step, and was lowest for the four-parameter model (Table 3), indicating that the full four-parameter model is also the most parsimonious and not over-parameterized.

The jackknife analysis indicated that including additional parameters with CPUE in the forecast model could substantially improve forecasts for SEAK harvest (Table 4). Including May temperature data decreased the average absolute percent deviation of the jackknife forecasts from the actual harvests for 1998-2007 from 34% to 27%. For 2006, the year in which the actual forecast by the simple CPUE model was poor, including May temperature decreased the deviation of the jacknife forecast from the 2006 harvest from 201% to 103%. Adding ENSO data to the CPUE+May Temperature model did not improve forecast performance, but when June temperature replaced May temperature as indicated by the stepwise regression process (Table 3), jackknife forecast deviations for 1998-2007declined to an average of 12%, and to 51% for 2006. The full four-parameter model resulted in a further decline to 7%, and effectively predicted the 2006 harvest with a deviation of only 3%.

The 80% bootstrap confidence intervals of 2008 forecasts for the single and multiple parameter models were compared with the 80% prediction intervals from the regression equations (Figure 3). The prediction intervals declined markedly as the number of parameters in the model increased, from a range of 2-33 million fish for the simple CPUE model to a range of 17-26 million fish for the full four-parameter model. The decreasing intervals reflected the improved model fits and the corresponding reduction in process error. However, the regression prediction intervals did not incorporate measurement error because the observations of CPUE are single averages for each sampling year. The bootstrap confidence intervals incorporated the measurement error by randomly re-sampling the catches for 1000 iterations for each year. When measurement error was incorporated in this way, the confidence intervals increased with increasing parameterization of the models (Figure 3). For the simple CPUE model, the interval was 15-28 million fish. The two parameter model, CPUE + May Temperature, had a slightly wider interval (13-27 million), while the three-parameter model had an interval of 11-27 million, and the full model interval was 12-41 million.

All SEAK forecast models we evaluated gave low predictions for 2008 harvest, ranging from 14-21 million (Table 3). The ADF&G forecast, modified with the SECM juvenile pink salmon CPUE data, is similar at 19 million (personal communication, Steve Heinl, Alaska Department of Fish and Game). If the harvest is in this range, it will be the second lowest in the past 20 years. The low forecasts are a direct result of the low juvenile CPUE in the northern strait habitat in 2007; they are the lowest observed during the SECM time series (Figure 1), indicating poor recruitment to the marine environment. Low catches in the southern strait habitat (discussed below) corroborates the conclusion that recruitment to the strait habitat was poor. The 2006 escapement index was the lowest since 1990 (personal communication, Steve Heinl, Alaska Department of Fish and Game). The winter of 2006-2007 was severe, and the winter and early spring were extremely cold. At Auke Creek weir in Northern SEAK, the January-April 2007 water temperatures were the lowest on record, and pink salmon fry outmigration was approximately a week later than normal (Taylor 2008). Late timing of fry outmigration can result in reduced marine survival of pink salmon juveniles (Mortensen et al. 2000). These ancillary observations give credibility to the low forecast range.

Which of the CPUE models in Table 3 is the “best” predictor of the 2008 SEAK harvest? The one-parameter model, using only juvenile CPUE, is inadequate because it explained only 80% of the variability, and has a very wide regression prediction interval reflecting the large process error in the model. The multi-parameter models that included June temperature data and the ENSO index fit the data well and performed better in the jackknife analysis. The full, four-parameter model had the best fit to the data, the lowest AIC, and the lowest deviation in the jackknife analysis both overall and for the 2006 harvest. However, the bootstrap confidence intervals of the forecast from this model had the widest range, indicating substantial uncertainty. In contrast, the two- parameter model fit the data reasonably well (adjusted R^2 = 93%), and had much narrower bootstrap confidence intervals. The three-parameter model using juvenile CPUE, June temperatures, and ENSO was intermediate in performance between the two- and four-parameter models.

These three models were further tested by truncating the data set and forecasting the harvest with reduced data for 2004-2007. The complete data set through the 2003 juvenile year (including 2004 harvest) was used to generate the models to forecast 2005 harvest with 2004 juvenile data, the complete data set through the 2004 juvenile year (including 2005 harvest) was used to generate the models to forecast 2006 harvest with 2005 juvenile data, and the complete data set through the 2005 juvenile year (including 2006 harvest) was used to generate the models to forecast 2007 harvest with 2006 juvenile data. The results are shown in Figure 4. The two and three parameter models were very similar in performance, with the two-parameter model better for 2006 and the 3-parameter model better in 2007. The total absolute deviation over the three forecast years relative to the total harvest of 116 million fish was marginally better for the three parameter model (14 million) than the two-parameter model (16 million). The four-parameter model performed the worst in 2005, but was much better in 2006, and was similar to the other models in 2007 (Figure 4). The total absolute deviation for this model was 8 million fish.

Although the results for the models with June temperature and ENSO data are very promising, we selected the two-parameter model prediction as the "best" forecast for 2008 for the following reasons. First, the improvement in performance in the truncated data sets for these models relative to the two-parameter model was not large and was not consistent for each year tested. Second, the three- and four-parameter models had larger uncertainty in the bootstrap output (Figure 3). Third, the two-parameter model performed well in 2007, while the other models are as yet untested for an actual pre-season forecast. Finally, the two-parameter model provided a forecast intermediate between the three- and four-parameter models (Table 3). Thus at the SEAK Purse Seine Task Force meeting in Sitka in November, 2007, we presented a forecast of 16.1 million (13 million-27 million, 80% confidence interval) as our best estimate for the 2008 harvest.

4.1.3 Sub-objective 1A: Geographic Scope

To evaluate the effect of geographic scope on model performance, linear models using harvest for Northern Southeast Alaska Inside (NSEI) as the dependent parameter were developed and compared with the juvenile CPUE models using total SEAK harvest as the dependent parameter for the 2008 forecast (Table 3). The best model for NSEI harvest was the simple linear regression with Peak CPUE; no other variable considered, including May temperatures, significantly improved this model. The amount of variation explained by the NSEI model was 74%, less than for SEAK models (80%-99%), indicating no improvement in fit by restricting the harvest data to NSEI. Jackknife analyses showed that the average annual deviation of jackknife forecasts to actual harvests for 1998-2007 was similar for the one-parameter models for SEAK and NSEI, and that the NSEI model also had a lower deviation for the anomalous 2006 return (Table 4). However, the three- and four- parameter models for SEAK harvest had substantially lower deviation overall and for the 2006 harvest. These results indicate that model performance was not improved by restricting the geographic scope of the harvest forecast.

4.1.4 Sub-objective 1B: Measurement Error

Random re-sampling of the catch data with replacement for each year provided a mechanism to incorporate measurement error into the forecast models output. Bootstrap confidence intervals were narrower than the prediction CIs generated from the regression equation for the single parameter CPUE models (Figure 3). We attribute the wider CIs of the regression predictions to the reduction in degrees of freedom resulting from using average values as indicators of juvenile CPUE abundance in the regression equation. As the number of parameters in the models increased, the multiple regression prediction intervals narrowed, reflecting the excellent fit (R2 > 90%, Table 3) of the multiple regression error and the corresponding reduction in process error. However, the bootstrap CIs increased with increasing parameterization, indicating that the models with more predictor variables were more sensitive to measurement error.

4.1.5 Sub-objective 3: Escapement

The average ratio of harvest to escapement index counts for 1998 to 2006 pink salmon returns to SEAK was 2.49 (Table 5). This scalar was used to estimate an adjusted total escapement index, which was summed with harvest to produce the total run index. The total run index ranged from 1.8 to 3.2 times greater than the harvest for a particular year (Table 5), indicating interannual variation in exploitation rates. However, the total run index was highly correlated with harvest ($r = 0.99$). This high correlation resulted in little difference in the prediction of harvest when total run was used instead of harvest alone as the prediction variable (Table 6). Similar results were found for the NSEI escapement and harvest relationships. Forecast models using harvest data are preferable at this time, because of the large uncertainty in the escapement index data, and the small differences incorporating the adjusted total escapement into the forecast.

4.2 Objective 2: Abundance and Growth in Northern and Southern Areas

Juvenile pink salmon abundance was typically higher in the southern area (Table 7). The pattern of abundance was similar for the two areas. Peak and overall average CPUEs were highest in both areas in 2006, and lowest in both areas in 2007. CPUEs were higher in June in both areas in 2005 and 2006, and higher in July in both areas in 2007. In both areas, there was a pronounced decline in CPUE from June to July in 2005.

Juvenile chum salmon peak CPUEs were also lowest in both areas in 2007, but in contrast to pink salmon, were highest in 2005 for both areas (Table 7). Peak CPUE was higher in the northern area in 2005 and 2006, but higher in the southern area in 2007.

Similar to pink salmon, juvenile chum salmon CPUEs tended to peak in June in 2005 and 2006, and in July in 2007.

Growth rates and fish size varied between areas and species. Juvenile pink salmon had higher growth rates in the southern area in 2005 and 2006, and in the northern area in 2007 (Table 8). Average size of juvenile pink salmon on July 24 was greater in the southern area in 2006, but was greater in the northern area in 2005 and 2007. For juvenile chum salmon, apparent growth was higher in the southern area in 2005, and higher in the northern area in 2006 and 2007 (Table 8). However, the pattern of chum salmon size on July 24 was similar to pink salmon: average size was larger in the southern in 2006, and in the northern area in 2005 and 2007.

Higher apparent growth rates between June and July samples were not consistently associated with higher estimated average size on July 24, e.g., pink salmon in the southern area in 2005 (Table 8). This may indicate area differences in growth history prior to the June sampling period, or the effects of regional and interannual differences in size-selective predation.

4.3 Objectives 3 and 4: Juvenile Pink and Chum Salmon Consumption and Trophic Demand

4.3.1 Temperature and zooplankton data for bioenergetic model

Temperatures were warmer at the 3-m depth in both areas and time periods compared to the 20-m integrated averages in June and July, 2005 (Table 9). These temperatures ranged from 10.9 to 15.2 °C. Between areas, temperatures were generally warmer in the southern area by anywhere from 1.5 to 2.9 °C, although temperatures were identical at the surface in late June.

Average zooplankton standing crop was consistently higher in the Icy Strait habitat compared to the Clarence Strait habitat in 2005 (Table 10). The calculated standing crops were higher in June than July in the Icy Strait habitat for both mesh net sizes. In Clarence Strait, zooplankton standing crop also declined from June to July based on samples from the 333-µm mesh net, but increased based on samples from the 505-µm mesh net. Average densities of zooplankton in 2005 in Icy Strait ranged from5 8.8 to 145.4 g/m^2, whereas, the average densities in Clarence Strait ranged from 25.2 to 39.1 g/m^2.

4.3.2 Juvenile salmon abundance, size, and growth data for bioenergetic model

Juvenile pink and chum salmon were more abundant in June than in July 2005 (Table 7). In June, juvenile chum salmon abundances were highest in Icy Strait whereas juvenile pink salmon abundances were highest in Clarence Strait. For each species and stock groups, densities ranged from 391 to 2,313 fish/km^2 in June and from 7 to 144 fish/km^2 in July (Table 11). The highest density of any species or stock group was found for juvenile pink salmon in the southern area in June. The next highest density was found for hatchery chum salmon in Icy Strait, where the Macaulay Hatchery (MC) and Hidden Falls Hatchery (HF) chum salmon densities were 879 and 828 fish/km^2, respectively.

The size of juvenile salmon was greatest in July in 2005 for each species and stock group (Table 12). In most cases, fish sizes were larger in Icy Strait compared to Clarence Strait. Apparent growth rates of each species and stock group ranged from 0.10 to 0.55 g/d in Icy Strait and 0.26 to 0.36 g/d in Clarence Strait.

The WBEC was higher for juvenile pink salmon (4.2-4.5 kJ/g wet wt) than chum salmon (3.8-4.3 kJ/g wet wt) in both the northern and southern areas (Table 13). Values for WBEC tended to be higher in Icy Strait compared to Clarence Strait; consequently WBEC was highest for pink salmon in Icy Strait and lowest for chum salmon in Clarence Strait.

4.3.3 Prey and predator energy densities and physiological parameters

Prey WBEC and the indigestible percentage of each prey type used in the model were derived from literature values and are summarized in Table 14. Prey energy densities were used from five sources: Thayer et al. (1973), Nishiyama (1977), Davis et al. (1998), Yerokhin and Shershneva (2000), and Boldt and Haldorson (2002). These literature prey energy densities were chosen whenever possible to reflect the study time period. The indigestible percentage of each prey type was taken from Davis et al. (1998), or assumed to be 10%.

The prey fields consumed by the juvenile salmon indicated species-specific, habitat-specific, and temporal differences (Figure 6,7). Pink salmon consumed a higher proportion of gastropods and calanoid copepods than chum salmon. Chum salmon consumed a high proportion of oikopleurans than pink salmon. Between areas, the proportion of amphipods and decapod larvae consumed was lower in Icy Strait (Figure 2) than in Clarence Strait (Figure 3). Shifts in diet were also apparent in both areas by time period: oikopleurans were consumed in higher proportions in June while euphausiids were consumed in higher proportions in both areas in July.

4.3.4 Consumption and trophic demand

Consumption rates calculated by the bioenergetics model were consistently higher than consumption rates by juveniles in the 3-m surface temperature simulation than in the 20-m integrated temperature simulation (Table 15). This finding was consistent for each species and stock group and in each sampling period. The warmer simulation increased consumption by about 5-12% in each area and time period.

Zooplankton consumption by juvenile salmon was lower in both areas during July than in June (Table 16). This was due to the lower abundance of both species and lower consumption rates in July. Juvenile pink salmon consumed more prey than juvenile chum salmon in the southern area, and less than juvenile chum salmon in the northern area. Hatchery chum salmon consumed a larger proportion of the total chum salmon consumption in both northern and southern areas. Hatchery chum salmon consumed 84% (June) and 63% (July) of the total prey consumed by chum salmon in the northern area, and 60% (June) and 57% (July) in the southern area.

Despite higher consumption by juvenile salmon in June, the percent consumption of the standing crop of zooplankton was low (Table 17). This was consistent for standing crop as measured by either the 333-µm mesh net or the 505-µm mesh net. Zooplankton consumption by juvenile salmon was lower in both northern and southern areas in July compared to June due to the lower densities of both salmon species and lower consumption rates in July. The highest combined consumption by all stock groups of juvenile pink and chum salmon was 0.01% of the zooplankton/ km^2 (0.13% zooplankton/ m^3) in the southern area during June (Table 17).

The low consumption rate of integrated water column zooplankton is consistent with the findings of Orsi et al. (2004) for juvenile chum salmon in Icy Strait. In that study, juvenile chum salmon consumed only 0.005% of the zooplankton/km^2 for the integrated water column in June and July in 2001. Because juvenile salmon are typically in the upper water column, total standing crop of zooplankton is not likely to be available as forage. Orsi et al. (2001) found that when only the upper 20-m zooplankton was considered as the forage base for juvenile salmon, the proportion consumed by juvenile chum salmon increased by approximately an order of magnitude, to 0.04% of the zooplankton/km^2. A similar relative increase in this study would still result in low trophic demand in the upper water column in 2005, with juvenile pink and chum salmon consuming less than 0.2% of the available zooplankton/km^2.

5 LITERATURE CITED

ADFG (2007) Recent years harvest statistics. Alaska Department Fish and Game Commercial Fisheries Division. http://www.cf.adfg.state.ak.us/cf_home.htm.

Beamish, R. J. and C. Mahnken. 2001. A critical size and period hypotheses to explain natural regulation of salmon abundance and the linkage to climate and climate change. Progress in Oceanography 49:423-437.

Boldt, J. L. and L. J. Haldorson. 2002. A bioenergetics approach to estimating consumption of zooplankton by juvenile pink salmon in Prince William Sound, Alaska. Alaska Fisheries Research Bulletin 9(2): 111-127.

Davis, N. D., K. W. Meyers, and Y. Ishida. 1998. Caloric value of high-seas salmon prey organisms and simulated salmon ocean growth and prey composition. North Pacific Anadromous Fish Commission Bulletin No. 1: 146-162.

Eggers, D. 2005. Run forecasts and harvest projections for 2005 Alaska salmon fisheries and review of the 2004 season. Alaska Dept. Fish Game Spec. Publ. 05-01. 83 p.

Eggers, D. 2006. Run forecasts and harvest projections for 2006 Alaska salmon fisheries and review of the 2005 season. Alaska Dept. Fish Game Spec. Publ. 06-07. 83 p.

Eggers, D. 2007. Run forecasts and harvest projections for 2007 Alaska salmon fisheries and review of the 2006 season. Alaska Dept. Fish Game Spec. Publ. 07-01. 81p.

Hanson, P. C., T. B. Johnson, D. E. Schindler, and J. F. Kitchell. 1997. Fish bioenergetics 3.0 for Windows. Center for Limnology, University of Wisconsin-Madison and the University of Wisconsin Sea Grant Institute, Madison, Wis.

Mantua, N.J., Hare, S.R., Zhang, Y., Wallace, J.M., and Francis, R.C. (1997) A Pacific interdecadal climate oscillation with impacts on salmon production. Journal Climatology 8: 241-253.

Mortensen, D. G., A. C. Wertheimer, S. G. Taylor, and J. H. Landingham. 2000. The relation between early marine growth of pink salmon, *Oncorhynchus gorbuscha*, and marine water temperature, secondary production, and survival to adulthood. Fish. Bull. 98:319-335.

Moss, J. H., D. A. Beauchamp, A. D. Cross, K. W. Myers, E. V. Farley, J. M. Murphy, and J. H. Helle. 2005. Evidence for size-selective mortality after the first summer of ocean growth by pink salmon. Transactions of the American Fisheries Society 134:1313-1322.

NCDC. 2007. Multivariate ENSO index. NOAA Climate Data Center. www.cdc.noaa.gov/people/klaus.wolter/MEI/mei.html

Nishiyama, T., 1977. Food-energy requirements of Bristol Bay sockeye salmon *Oncorhynchus nerka* (Walbaum) during the last marine life stage. Research Institute of North Pacific Fisheries Special Volume, pp. 289-320. (In Japanese, English summary).

Orsi, J. A., A. C. Wertheimer, M. V. Sturdevant, E. A. Fergusson, D. G. Mortensen, and B. L. Wing. 2004. Juvenile chum salmon consumption of zooplankton in marine waters of southeastern Alaska: a bioenergetics approach to implications of hatchery stock interactions. Rev. Fish Biol. Fish. 14:335-359.

Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, A. C. Wertheimer, and W. R. Heard. 2006. Annual Survey of Juvenile Salmon and Ecologically Related Species and Environmental Factors in the Marine Waters of Southeastern Alaska, May–August 2005 (NPAFC Doc. 955) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 108 p.

Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, A. C. Wertheimer, and W. R. Heard. 2007. Annual Survey of Juvenile Salmon and Ecologically Related Species and Environmental Factors in the Marine Waters of Southeastern Alaska, May–August 2005 (NPAFC Doc. 1057) Auke Bay Laboratories, Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 17109 Point Lena Loop Road, Juneau, 99801, USA, 72 p.

Parker, R. R. 1968. Marine mortality schedules of pink salmon of the Bella Coola River, central British Columbia. J. Fish. Res. Bd. Can. 25: 757-794.

Plotnick, M., and D. M. Eggers. 2004. Run forecasts and harvest projections for 2004 Alaska salmon fisheries and review of the 2003 season. Alaska Dept. Fish Game Regional Inf.Rept. 5J04-01.

Shono, H. (2000) Efficiency of the finite correction of Akaike's information criteria. Fisheries Science 66: 608-610.

Taylor, S.G. 2008. Auke Creek Weir 2007 Annual Report, Operations, Fish Counts, and Historical Summaries. Unpublished Report 26 p. National Marine Fisheries Service, Auke Bay Fisheries Laboratory, 17109 Pt. Lena Loop Road, Juneau, Alaska 99801.

Thayer, G. W., W. E. Schaaf, J. W. Angelovic, and M. W. LaCroix. 1973. Caloric measurements if some estuarine organisms. Fishery Bulletin 71(1): 289-296.

Wertheimer A. C., J. A. Orsi, M. V. Sturdevant, and E. A. Fergusson. 2006. Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated environmental parameters. p. 65-72 *In*: H. Geiger (Rappoteur) (ed.), Proceedings of the 22nd Northeast Pacific Pink and Chum Workshop. Pacific Salmon Commission, Vancouver, British Columbia.

Willette, T.M., R. T. Cooney, V. Patrick, D. M. Mason, G. L. Thomas, and D. Scheel. 2001. Ecological processes influencing mortality of juvenile pink salmon (*Oncorhynchus gorbuscha*) in Prince William Sound, Alaska. Fish. Oceanogr. 10(1): 14-41.

Yerokhin, V. G. and V. I. Shershneva. 2000. Feeding and energy characteristics of juvenile pink salmon during fall marine migrations. N. Pac. Anadr. Fish. Comm. Bull. No. 2: 123-130.

6 TABLES AND FIGURES

Table 1. Harvests and predicted harvests for SEAK pink salmon returning in 2004-2007. Forecast models compared are SECM juvenile CPUE models and the ADF&G exponential smoothing model (ADF&G). Harvest numbers are in millions of fish.

Year/Forecast Model	Actual Harvest	Forecast Harvest	Forecast 80% CI	Deviation (%)
2004	**45.3**			
Peak CPUE		47.0	34.1-63.9[1]	3.8
JJ-Avg CPUE		40.9	18.7-63.1[1]	-9.7
ADF&G[2]		50	24-76	10.4
2005	**59.2**			
Peak CPUE		59.1	46.6-71.7[1]	-0.2
JJ-Avg CPUE		53.1	34.3-71.9[1]	-10.3
ADF&G[3]		49	25-72	-17.2
2006	**11.7**[4]			
Peak CPUE		35.2	28.8-42.6[5]	200.9
JJ-Avg CPUE		40.9	35.7-44.9[5]	249.6
Peak CPUE (includes Aug)		54.4	45.6-61.8[5]	365.0
JJA-Avg CPUE		54.9	49.0-61.1[5]	369.2
ADF&G[6]		52	29-74	344.4
2007	**44.8**[4]			
Peak CPUE		39.3	32.3-46.2[5]	-12.3
Peak CPUE + May Temp		40.2	29.0-52.0[5]	-10.3
ADF&G		58	33-83[6]	30.0
ADF&G with Juvenile CPUE		48	38-56[6]	7.0

[1]Parametric prediction intervals for the regression model.
[2]Plotnick and Eggers (2004)
[3]Eggers (2005)
[4]ADFG (2006) preliminary data
[5]Bootstrap confidence intervals for the regression model.
[6]Eggers (2006,2007)

Table 2. Correlation coefficient of CPUE of juvenile pink salmon and associated biophysical parameters in year *y* for 1997-2007 with adult pink salmon harvest in Southeast Alaska in year *y* + 1. Parameters with statistically significant correlations are in bold text.

Parameter	***r***	***P*-value**
Peak CPUE	**0.89**	**0.001**
August CPUE	-0.44	0.200
June-July Pink Salmon Apparent Growth	0.28	0.436
Pink Salmon Size July 24	0.54	0.108
Condition Index	-0.10	0.793
May/June Average Zooplankton Total Water Column	0.17	0.965
May/June Average Zooplankton 20-m	-0.06	0.876
May 3-m Water Temperature	-0.37	0.287
July 3-m Water Temperature	-0.04	0.903
May 20-m Integrated Water Temperature	-0.26	0.473
June 20-m Integrated Water Temperature	-0.29	0.411
June Mixed-layer Depth	-0.25	0.490
July 3-m Salinity	-0.24	0.505
Pacific Decadal Oscillation (Ocean Winter)	0.07	0.845
El Nino Southern Oscillation (Prior year annual average)	-0.03	0.943

Table 3. Regression models relating juvenile catch per unit effort (CPUE) of pink salmon in year *y* to adult harvest in Southeast Alaska in year *y* +1, for *y* = 1997-2006. R^2 = coefficient of determination for model; AIC_C = Akiake Information Criterion (corrected); *P* = statistical significance of regression equation. *SEAK* = total Southeast harvest; *NSEI* = harvest in Northern Southeast Alaska Inside Districts.

Model	**Harvest Area**	**Adjusted R^2**	**AIC_C**	**Regression *P* -value**	**2008 Prediction (millions)**
Ln(PeakCPUE)	SEAK	80%	80.9	0.001	17.4
Ln(PeakCPUE) + May20-mTemp	SEAK	93%	74.8	<0.001	16.1
Ln(PeakCPUE) + May20-mTemp + ENSO	SEAK	94%	74.3	<0.001	13.7
Ln(PeakCPUE) + June20-mTemp + ENSO	SEAK	98%	64.6	<0.001	15.0
Ln(PeakCPUE) + June20-mTemp + ENSO + July3-mSalinity	SEAK	99%	63.1	<0.001	21.2
Ln(PeakCPUE)	NSEI	74%	66.2	0.001	2.8

Table 4. Average absolute percent deviation of jackknife forecasts to observed harvests for forecast models for 1998-2007 returns of pink salmon for the Southeast Alaska region and for the northern inside portion of that region.. *SEAK* = total Southeast harvest; *NSEI* = harvest in Northern Southeast Alaska Inside Districts.

Model	**Harvest Area**	**Average Deviation**	**2006 Deviation**
Ln(PeakCPUE)	NSEI	33%	74%
Ln(PeakCPUE)	SEAK	34%	201%
Ln(PeakCPUE) + May20-mTemp	SEAK	27%	103%
Ln(PeakCPUE) + June20-mTemp +ENSO	SEAK	12%	51%
Ln(PeakCPUE) + June20-mTemp + ENSO + July3-mSalinity	SEAK	7%	3%

Table 5. Annual harvests, total escapement index counts, and estimated total run index incorporating weighted escapement counts for SEAK pink salmon, 1998-2005, in millions of fish. The weighting factor was the average annual ratio of harvest to the escapement index count.

Year	**Harvest[1]**	**Escapement Index[2]**	**Ratio Harvest/Esc**	**Weighted Escapement**	**Total Run Index**
1998	42.53	15.93	2.67	39.60	82.05
1999	77.77	30.46	2.55	75.67	153.50
2000	20.25	12.07	1.68	30.01	50.25
2001	67.05	19.20	3.49	47.72	114.74
2002	45.33	17.35	2.61	43.12	88.43
2003	52.52	21.30	2.47	52.92	105.39
2004	45.33	15.84	2.86	39.37	84.68
2005	59.11	20.26	2.92	50.35	109.46
2006	11.52	10.22	1.13	25.40	36.92
Average			2.49		

[1]ADFG (2006)
[2]Personal communication, Steve Heinl, Alaska Department of Fish and Game

Table 6. Predicted harvests in millions of fish for SEAK pink salmon in 2006 using juvenile catch per unit effort (CPUE) models with the dependent (predicted) variable either (1) an index of total run or (2) actual harvest. The predicted harvest from the total run forecast is estimated by assuming a 50% exploitation of the total run.

Model	**Dependent Variable Index Total Run**	**Predicted Harvest of Index Total Run**	**Dependent Variable Actual Harvest**
Peak CPUE (excludes Aug)	70.9	35.5	35.2
JJ-Avg CPUE	82.1	41.1	40.9
Peak CPUE (includes Aug)	107.5	53.2	54.4
JJA-Avg CPUE	108.3	54.1	54.9

Table 7. Catch per unit effort (CPUE) of juvenile pink and chum salmon in northern (NSE) and southern (SSE) areas of SEAK in June and July, 2005-2007.

Year	Area	June CPUE	JulyCPUE	JJAverage
		Pink Salmon		
2005	NSE	24.8	5.2	15.0
	SSE	83.3	4.3	43.8
2006	NSE	45.0	41.2	43.1
	SSE	153.4	35.9	94.6
2007	NSE	0.8	6.2	3.9
	SSE	9.7	12.3	10.9
		Chum Salmon		
2005	NSE	82.5	4.9	43.7
	SSE	34.1	15.2	24.6
2006	NSE	18.7	19.8	19.2
	SSE	15.2	10.4	12.8
2007	NSE	7.7	9.0	8.5
	SSE	24.8	10.4	18.2

Table 8. Apparent growth from June to July and estimated size on 24 July of juvenile pink and chum salmon in marine waters of northern (NSE) and southern (SSE) areas of Southeast Alaska, 2005-2007.

Year	**Area**	***n***	**Growth (mm/d)**	**Size (FL) on 24 July**
		Pink salmon		
2005	NSE	467	0.8	126.1
	SSE	1,066	1.0	119.7
2006	NSE	1,498	0.6	114.9
	SSE	1,287	1.0	129.2
2007	NSE	188	1.2	121.3
	SSE	177	0.3	111.5
		Chum salmon		
2005	NSE	943	0.5	125.4
	SSE	274	0.9	121.8
2006	NSE	801	1.0	131.9
	SSE	324	0.8	140.1
2007	NSE	406	1.2	119.8
	SSE	673	0.4	114.1

Table 9. Average temperature (°C) exposures used to model zooplankton consumption by juvenile chum salmon and pink salmon in Icy Strait and Clarence Strait in southeastern Alaska, June and July 2005. Monthly average temperatures represent the thermal experience of fish at a near- surface (3 m) and integrated (20 m) depth simulation.

			Late June		**Late July**	
Area	**Strait habitat**	**Depth**	***n***	**(°C)**	***n***	**(°C)**
Northern	Icy	3 m	20	14.1	23	13.1
	Icy	20 m integrated	20	10.9	22	11.4
Southern	Clarence	3 m	20	14.1	25	15.2
	Clarence	20 m integrated	20	12.4	25	14.3

Table 10. Average zooplankton standing crop measured in Icy Strait and Clarence Strait, southeastern Alaska in June and July 2005.

			Late June		Late July	
Area	**Strait habitat**	**Mesh (µ)**	**Average (g/m^2)**	**Average (g/m^3)**	**Average (g/m^2)**	**Average (g/m^3)**
Northern	Icy	333	145.4187	0.8076	72.3690	0.4685
	Icy	505	117.3239	0.6297	58.7633	0.3460
Southern	Clarence	333	46.3485	0.2184	32.9570	0.1629
	Clarence	505	25.2404	0.1191	39.0926	0.1950

Table 11. Average CPUE (catch per haul) of juvenile chum salmon and pink salmon in Icy Strait and Clarence Strait, southeastern Alaska in June and July 2005. The number of surface trawl hauls used to calculate juvenile salmon CPUE are shown for each habitat and time period.

				Late June			Late July		
Area	**Strait habitat**	**Salmon species**	**Stock group**	***n***	**CPUE**	**Density (fish/km²)**	***n***	**CPUE**	**Density (fish/km²)**
Northern	Icy	Chum	UM	20	21.05	585	23	2.79	77
	Icy	Chum	MC	20	31.64	879	23	0.27	7
	Icy	Chum	HF	20	29.81	828	23	1.86	51
	Icy	Pink	UM	20	24.15	688	23	5.17	144
Southern	Clarence	Chum	UM	20	14.07	391	20	2.95	82
	Clarence	Chum	NB	20	19.98	555	20	4.40	122
	Clarence	Pink	UM	20	83.25	2,313	20	4.30	119

Table 12. Size and growth of juvenile pink and chum salmon in Icy Strait and Clarence Strait, southeastern Alaska in June and July, 2005. Stock groups are UM=Unmarked fish, MC= Macaulay, HF=Hidden Falls, and NB=Neets Bay.

Area	Strait habitat	Salmon species	Stock group	Late June *n*	Late June Size(g)	Late July *n*	Late July Size (g)	Late June-Late July Growth rate (g/d)
Northern	Icy	Chum	UM	173	13.4	63	16.3	0.10
	Icy	Chum	MC	260	15.7	6	31.2	0.54
	Icy	Chum	HF	245	13.2	42	21.3	0.29
	Icy	Pink	UM	461	12.1	117	20.4	0.30
Southern	Clarence	Chum	UM	257	7.3	61	18.1	0.36
	Clarence	Chum	NB	365	8.8	91	17.5	0.29
	Clarence	Pink	UM	844	6.4	86	16.8	0.36

Table 13. Whole body energy content (WBEC) of juvenile pink and chum salmon sampled in Icy Strait and Clarence Strait, southeastern Alaska in June and July, 2005. Stock groups are UM=Unmarked fish, MC= Macaulay, HF=Hidden Falls, and NB=Neets Bay. The number of fish used for each stock group and species and their average bomb calorimetry values (J/g wet wt) are shown.

Area	Strait habitat	Salmon species	Stock group	Late June		Late July	
				n	WBEC	*n*	WBEC
Northern	Icy	Chum	UM	36	4273.7	20	4285.5
	Icy	Chum	MC	90	4271.6	5	4178.6
	Icy	Chum	HF	51	4213.2	20	4110.4
	Icy	Pink	UM	20	4537.2	18	4427.8
Southern	Clarence	Chum	UM	64	3715.1	23	4112.6
	Clarence	Chum	NB	108	3794.5	38	4029.8
	Clarence	Pink	UM	20	4204.3	15	4339.6

Table 14. Energy values prey used for diet items consumed by juvenile salmon in Icy Strait and Clarence Strait, southeastern Alaska in June and July 2005. Energy values are given as J/cal wet wt (1 g = 4.186 J). Literature used to obtain each prey energy value is given.

Prey group	Name or species	Month	Energy content (J/g wet wt)	Indigestible percentage	Literature source
Cnidarians	Small medusae	June-July	569.3	11.25	Davis et al. (1998)
Gastropods	*Limacina* spp.	June-July	2,612.1	9.07	Davis et al. (1998)
Euphausiids	*Thysanoessa* spp.	June-July	3,110.2	10.35	Davis et al. (1998)
Copepods	Calanoid	June-July	2,624.6	9.04	Davis et al. (1998)
Copepods	Harpacitcoid	–	3,810.7	9.04	Boldt and Haldorson (2002)
Amphipods	Hyperiid	July	2,465.6	12.99	Davis et al. (1998)
Teleosts		–	5010.6	8.98	Nishiyama (1977)
Oikopleurans	Larvacean	June	3,177.2	10.00	Davis et al. (1998)
Chaetognaths	Arrow worms	–	2,888.3	10.00	Yerokhin and Shershneva (2000)
Decapods	Crab larvae	–	2980.4	10.00	Nishiyama (1977)
Arthropods	Barnacle nauplii	–	2,045.3	10.00	Thayer et al. (1973)
Other	General unidentified	–	2,485.4	10.48	Averaged from consumed prey proportion

Table 15. Zooplankton consumption rates of juvenile pink and chum salmon stock groups calculated from 28 bioenergetics model runs based on biophysical parameters in Icy Strait and Clarence Strait, southeastern Alaska in June and July, 2005. Stock groups are UM=Unmarked fish, MC= Macaulay, HF=Hidden Falls, and NB=Neets Bay. The two temperature simulations used to model consumption (3 m depth and 20 m integrated) rates are shown in Table 9.

				Consumption rates of zooplankton (g of prey/ g of predator/ d)			
	Strait	**Salmon**	**Stock**	**Late June temp. simulations**		**Late July temp. simulations**	
Area	**habitat**	**species**	**group**	**3 m**	**20 m integrated**	**3 m**	**20 m integrated**
Northern	Icy	Chum	UM	0.049302	0.042376	0.046044	0.040637
	Icy	Chum	MC	0.084087	0.074917	0.069012	0.063129
	Icy	Chum	HF	0.085867	0.074488	0.074348	0.066227
	Icy	Pink	UM	0.092518	0.081109	0.079236	0.071326
Southern	Clarence	Chum	UM	0.121122	0.113258	0.096114	0.091469
	Clarence	Chum	NB	0.104449	0.096849	0.088040	0.083078
	Clarence	Pink	UM	0.141971	0.133533	0.111062	0.106315

Table 16. Zooplankton consumed by juvenile pink salmon and chum salmon stock groups calculated from 28 bioenergetics model runs based on biophysical parameters in Icy Strait and Clarence Strait, southeastern Alaska in June and July, 2005. Stock groups are UM=Unmarked fish, MC= Macaulay, HF=Hidden Falls, and NB=Neets Bay. Zooplankton consumed is based on the 3 m temperature simulation that yielded the highest consumption rates (Table 15). The amounts of zooplankton consumed are presented for surface area ($g/km^2/d$) and volume ($g/m^3/d$) in the upper 18-m.

Area	**Strait habitat**	**Salmon species**	**Stock group**	**Zooplankton consumed ($g/km^2/d$)**		**Zooplankton consumed ($g/m^3/d$)**	
				Late June	**Late July**	**Late June**	**Late July**
Northern	Icy	Chum	UM	387	58	0.020	0.003
	Icy	Chum	MC	1,160	16	0.061	0.001
	Icy	Chum	HF	936	81	0.049	0.004
	Icy	Pink	UM	771	233	0.040	0.018
	Total			3,254	388	0.171	0.026
Southern	Clarence	Chum	UM	345	143	0.018	0.008
	Clarence	Chum	NB	511	188	0.027	0.010
	Clarence	Pink	UM	2,098	222	0.111	0.012
	Total			2,954	553	0.156	0.029

Table 17. The percentage of available zooplankton consumed by juvenile pink salmon and chum salmon stock groups calculated from 28 bioenergetics model runs based on biophysical parameters in Icy Strait and Clarence Strait, southeastern Alaska in June and July, 2005. Stock groups are UM=Unmarked fish, MC= Macaulay, HF=Hidden Falls, and NB=Neets Bay. The percent consumed shown here is based on the 3 m temperature simulation that yielded the highest consumption rates shown in Table 15. The percentage consumption is also determined for two zooplankton sample measurements (333 µ mesh and 505 µ mesh) and two metrics (surface area km^2 and m^3).

				Consumption km^2				Consumption m^3			
				Late June		Late July		Late June		Late July	
Area	**Strait habitat**	**Salmon species**	**Stock group**	**333**	**505**	**333**	**505**	**333**	**505**	**333**	**505**
Northern	Icy	Chum	UM	0.000	0.000	0.000	0.000	0.003	0.003	0.001	0.001
	Icy	Chum	MC	0.001	0.001	0.000	0.000	0.008	0.010	0.000	0.000
	Icy	Chum	HF	0.001	0.001	0.000	0.000	0.006	0.008	0.001	0.001
	Icy	Pink	UM	0.001	0.001	0.000	0.000	0.005	0.006	0.004	0.005
	Total			0.002	0.003	0.001	0.001	0.021	0.027	0.006	0.007
Southern	Clarence	Chum	UM	0.001	0.001	0.000	0.000	0.008	0.015	0.005	0.004
	Clarence	Chum	NB	0.001	0.002	0.001	0.000	0.012	0.023	0.006	0.005
	Clarence	Pink	UM	0.005	0.008	0.001	0.001	0.051	0.093	0.007	0.006
	Total			0.006	0.012	0.002	0.001	0.072	0.131	0.018	0.015

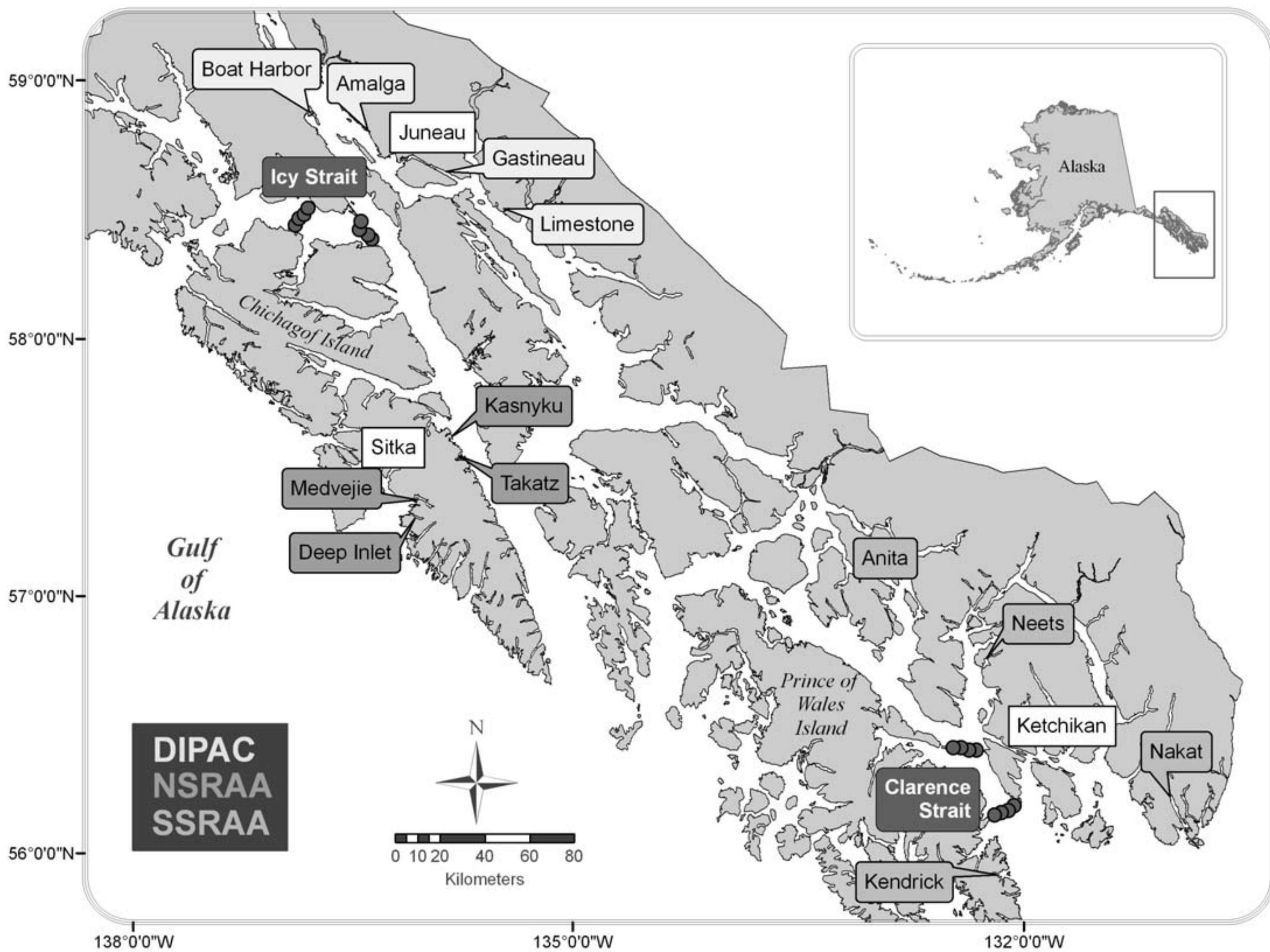

Figure 1. The Icy Strait and Clarence Strait study localities sampled in the northern and southern areas of southeastern Alaska, June–July 2005. Primary chum salmon hatcheries and release sites are identified (DIPAC, NSRAA, and SSRAA).

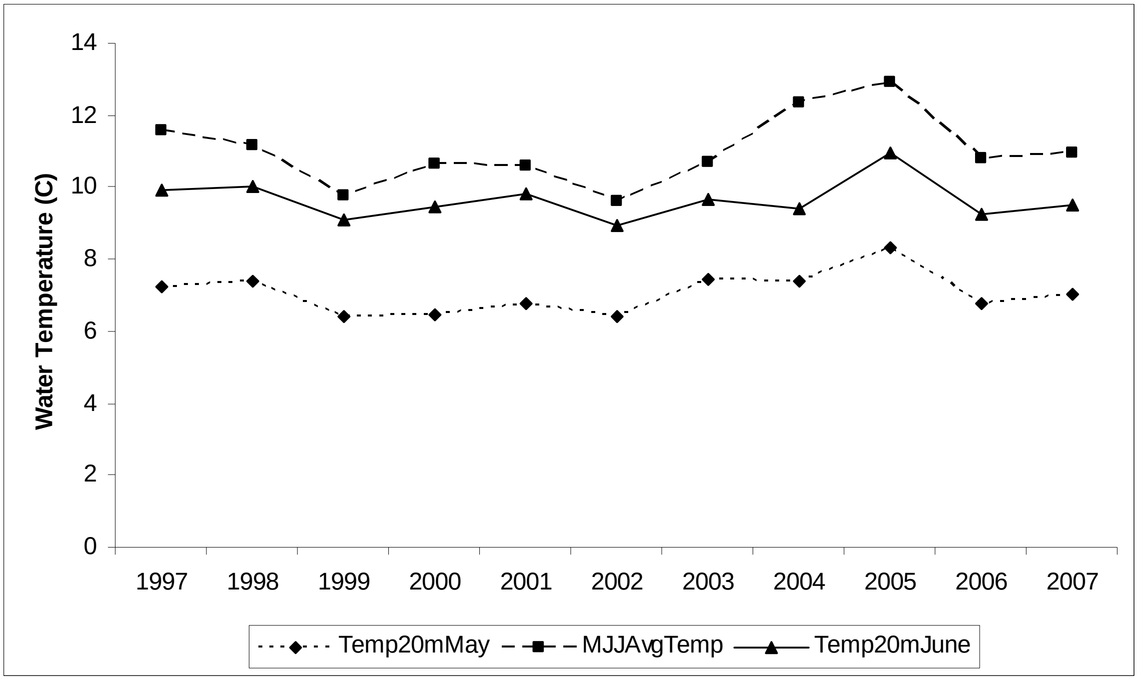

Figure 2. Water temperatures in strait habitats in northern Southeast Alaska, 1997-2007. May and June temperature lines are averages of 1-m depth profiles of the upper 20-m; MJJ is the May/June/July average temperature at 3-m depth.

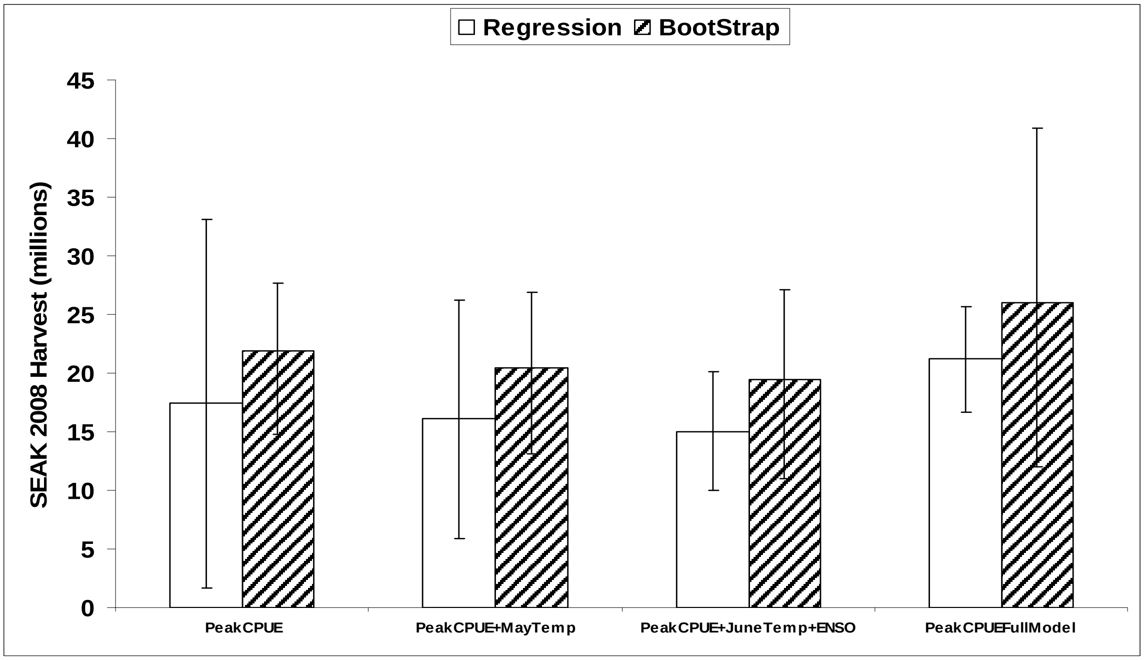

Figure 3. Parametric regression and bootstrap 80% confidence intervals for predictions of SEAK pink salmon harvest in 2006 from juvenile CPUE data in 2005.

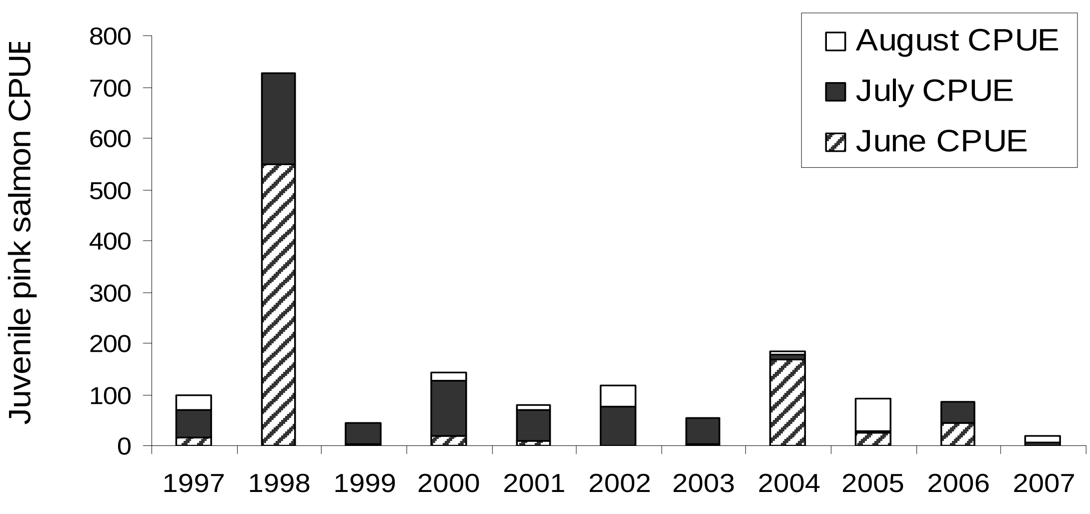

Figure 4. Catch per unit effort of juvenile pink salmon in northern strait habitats, 1997-2007.

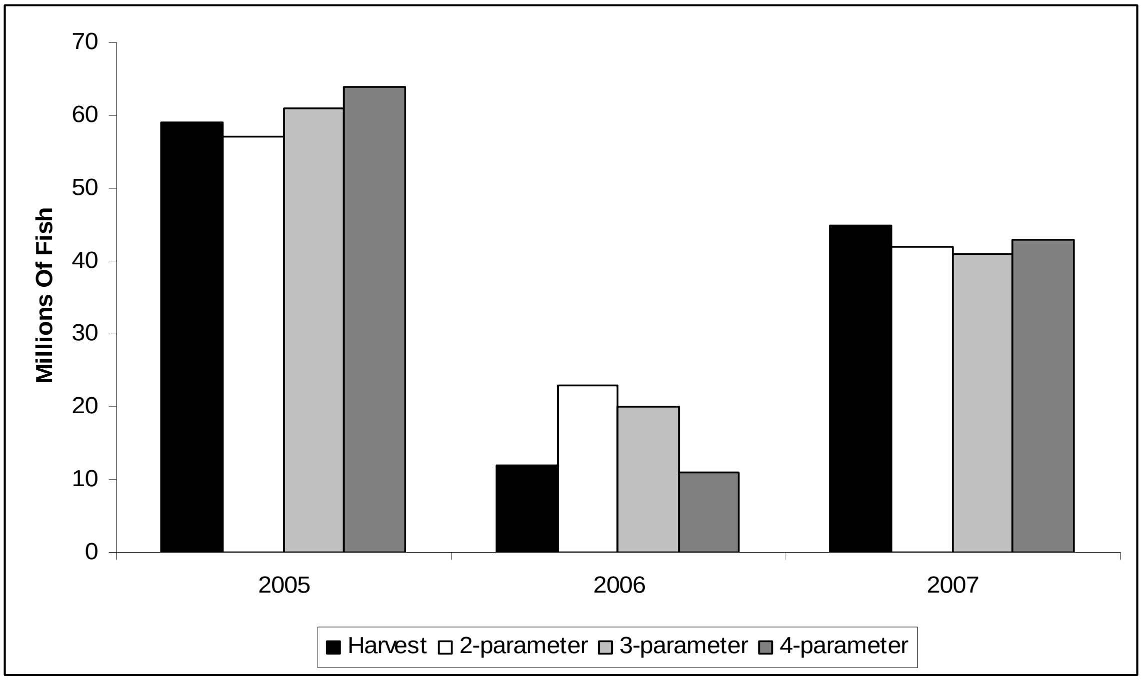

Figure 5. Forecasts for 2005-2007 from truncated data sets for three forecast models: 2-parameter (CPUE + May temperatures); 3-parameter (CPUE + June temperatures + ENSO); and 4-parameter (CPUE + June temperatures + ENSO + Jul salinity. “Harvest” = actual SEAK pink salmon harvest.

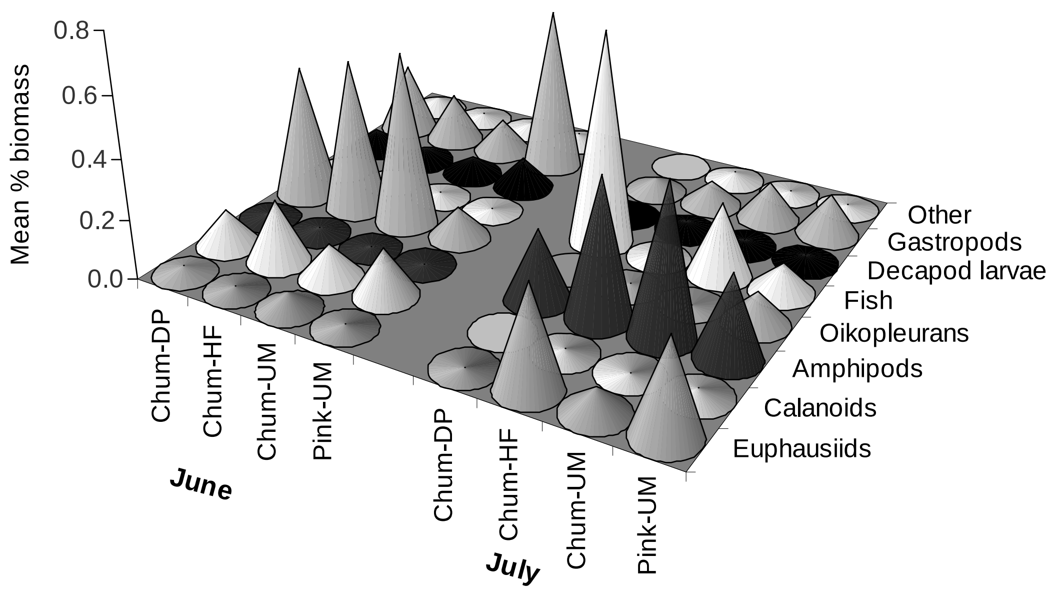

Figure 6. Diet of major prey types consumed by juvenile chum and pink salmon in the marine waters of Icy Strait in the northern area of southeastern Alaska, 2005. The acronym following the dash after the species identifies the stock group: DP = Douglas Island Pink and Chum Hatchery, HF = Hidden Falls Hatchery, and UM = Unmarked stock groups. Hatchery localities are shown in Figure 1.

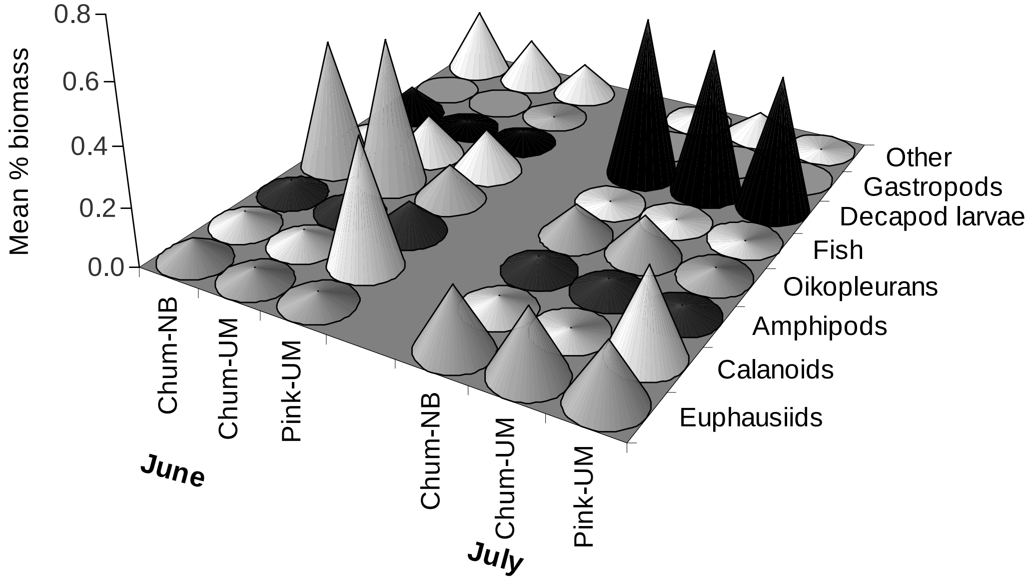

Figure 7. Diet of major prey types consumed by juvenile chum and pink salmon in the marine waters of Clarence Strait in the southern area of southeastern Alaska, 2005. The acronym following the dash after the species identifies the stock group: NB = Neets Bay Hatchery and UM = Unmarked stock groups. Hatchery localities are shown in Figure 1.

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Annual Survey of Juvenile Salmon and Ecologically Related Species and Environmental Factors in the Marine Waters of Southeastern Alaska, May–August 2005

by

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Annual Survey of Juvenile Salmon and Ecologically Related Species and Environmental Factors in the Marine Waters of Southeastern Alaska, May–August 2005

Abstract

Juvenile Pacific salmon (*Oncorhynchus* spp.), ecologically-related species, and associated biophysical data were collected by the Southeast Coastal Monitoring Project along primary marine migration corridors in the southern and northern regions of southeastern Alaska. Up to 17 stations were sampled in four time periods (40 sampling days) from May to August 2005. This survey marked the ninth consecutive year of systematic monitoring of how juvenile salmon interact in marine ecosystems, and was implemented to identify the relationships among biophysical parameters that influence the habitat use, marine growth, predation, stock interactions, and year-class strength of salmon. Typically, at each station, fish, zooplankton, physical profile data, and water samples were collected using a surface rope trawl, conical and bongo nets, a conductivity-temperature-depth profiler, and a water sampler during daylight. Surface (3-m) temperatures and salinities ranged from 9.3 to 15.7 ºC and 13.8 to 31.5 PSU over the season. A total of 6,874 fish and squid, representing 19 taxa, were captured in 92 rope trawl hauls from June to August. Juvenile salmon comprised 96% of the total fish and squid catch in each region. Juvenile salmon occurred frequently in both regions, with pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), and coho (*O. kisutch*) occurring in 63-86% of the trawl hauls, and juvenile Chinook salmon occurring in 20-25% of the trawl hauls. Of the 6,651 salmonids caught, over 99% were juveniles. In both regions, only two non-salmonid species represented >1% of the catch: market squid (*Loligo* spp.) in the southern region (2%) and crested sculpin (*Blepsias bilobus*) in the northern region (2%). Temporal and spatial differences were observed in the catch rates, size, condition, and stock of origin of juvenile salmon species. Catch rates of juvenile salmon were highest in June for all species except pink salmon, which had the highest catch rates in August. Size of juvenile salmon increased steadily throughout the season; mean fork lengths in June, July, and August were, respectively: 92, 127, and 170 mm for pink; 108, 124, and 191 mm for chum; 115, 123, and 180 mm for sockeye; 184, 207, and 239 mm for coho; and 205, 245, and 255 for Chinook salmon. Coded-wire tags were recovered from 17 juvenile coho, 6 juvenile Chinook, and 2 immature Chinook salmon; all but six of these fish were from hatchery and wild stocks of southeastern Alaska origin. The non-Alaska stocks were juvenile coho and Chinook salmon originating from Oregon and Washington. Alaska enhanced stocks were also identified by thermal otolith marks from 53% of the chum, 18% of the sockeye, 9% of the coho, and 50% of the Chinook salmon. Onboard stomach analysis of 63 potential predators, representing eight species, revealed one predation instance on juvenile salmon by a spiny dogfish (*Squalus acanthias*). Forecasting models using catch-per-unit effort (CPUE) of juvenile pink salmon in strait habitat of the northern region in 2003 and 2004 produced accurate predictions of southeastern Alaska pink salmon harvests in 2004 and 2005. However, the models using 2005 CPUE as a predictor overestimated harvest of pink salmon in 2006, indicating that CPUE alone is not sufficient to consistently predict year class strength. These results suggest that in southeastern Alaska, juvenile salmon exhibit seasonal patterns of habitat use and abundance, and display species- and stock-dependent migration patterns. Long-term monitoring of key stocks of juvenile salmon, on both intra- and interannual bases, will enable researchers to better understand ecological interactions that affect interannual variation in salmon abundance and the role that salmon play in North Pacific marine ecosystems.

Introduction

The Southeast Coastal Monitoring Project (SECM), a long-term fisheries oceanography study in southeastern Alaska, was initiated in 1997 to annually study the early marine ecology of Pacific salmon (*Oncorhynchus* spp.) and ecologically related species, and to better understand effects of environmental change on salmon production. Salmon are a keystone species that constitute important ecological links between marine and terrestrial habitats, and therefore play a significant, yet poorly understood, role in marine ecosystems. Fluctuations in the survival of this important living marine resource have broad ecological and socioeconomic implications for coastal localities throughout the Pacific Rim. Increasing evidence for relationships between production of Pacific salmon and shifts in climate conditions has renewed interest in processes governing salmon year-class strength (Beamish 1995). In particular, climate variation has been associated with ocean production of salmon during El Niño and La Niña events, such as the recent warming trends that benefited many wild and hatchery stocks of Alaskan salmon (Wertheimer et al. 2001). However, research is lacking in areas such as the links between salmon production and climate variability, between intra- and interspecific competition and carrying capacity, and between stock composition and biological interactions. Past research has not provided adequate time-series data to explain such links (Pearcy 1997). Because the numbers of salmonids produced in the region have increased over the last few decades (Wertheimer et al. 2001), mixing between stocks with different life history characteristics has also increased. The consequences of such changes for the growth, survival, distribution, and migratory rates of salmonids remain unknown.

One SECM goal is to identify mechanisms linking salmon production to climate change using a time series of synoptic data that combines stock-specific life history characteristics of salmon with ocean conditions. Until recently, stock-specific information relied on labor-intensive methods of marking individual fish, such as coded-wire tagging (CWT; Jefferts et al. 1963), which could not practically be applied to all of the fish released by enhancement facilities. However, mass-marking with thermally induced otolith marks (Hagen and Munk 1994) is a technological advance that is currently implemented in many parts of Alaska. The high incidence of these marking programs in southeastern Alaska (Courtney et al. 2000) offers an opportunity to examine growth, survival, and migratory rates of specific salmon stocks during a period of high levels of regional hatchery production of hatchery chum salmon (*O. keta*) and historically high returns of wild pink salmon (*O. gorbuscha*). In 2005 for example, over 400 million chum salmon were released from hatcheries in southeastern Alaska (White 2006). Of those releases, over 340 million were otolith-marked juvenile chum salmon released by three private non-profit enhancement facilities. Consequently, over the past decade, commercial harvests of adult chum salmon in the common property fisheries in southeastern Alaska have averaged about 11.7 million fish annually (ADFG 2006). These harvests are represented by a high proportion of fish released from regional enhancement facilities. In 2005 for example, 61% of the chum salmon harvested in southeastern Alaska was comprised of enhanced fish (White 2006). In addition to chum salmon, sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and Chinook salmon (*O. tshawytscha*) are also otolith-marked by some enhancement facilities. Therefore, examining the early marine ecology of marked stocks along with unmarked stocks provides an opportunity to study stock-specific abundance, distribution, and species interactions of juvenile salmon that will later recruit to the fishery.

Increased hatchery production of juvenile salmon in southeastern Alaska has raised concern over potential hatchery and wild stock interactions during their early marine residence. A recent study using a bioenergetics approach and SECM data from Icy Strait concluded that hatchery and wild stocks consumed only a small percentage of the available zooplankton (Orsi et al. 2004a); this study also suggested that abundant vertically-migrating planktivores (e.g., walleye pollock (*Theragra chalcogramma*)) could have a greater impact on the zooplankton standing stock than hatchery stock groups of chum salmon. These findings stress the importance of examining the entire epipelagic community of ecologically-related species in the context of trophic interactions (Park et al., 2004; Sturdevant et al. 2004, 2005; Orsi et al. 2006, in press; Brodeur et al. in press; Weitkamp et al. in press).

To broaden the SECM research scope in southeastern Alaska, sampling was expanded in 2005 to include strait habitats within the southern region. This new focus on regional comparisons is supported by funding from the Northern Fund of the Pacific Salmon Commission over a 3-year period, and emphasizes 1) forecasting of adult pink salmon returns from juvenile pink salmon abundance, and 2) understanding differences in trophic dynamics using bioenergetics models.

The Northern Fund forecasting component will develop and test forecast models for southeastern Alaska pink salmon using juvenile catch-per-unit-effort (CPUE) data. Because of poor pre-season forecasting success and large uncertainty in estimating escapement numbers, the Alaska Department of Fish and Game (ADFG) no longer uses a spawner/recruit approach to forecast southeastern Alaska pink salmon, but instead predicts future harvests from the time series of prior harvest using an exponential smoothing model (Plotnick and Eggers 2004; Eggers 2005). Because mortality of juvenile pink salmon is high and variable during their initial marine residency, it may be a major determinant of year-class strength (Parker 1968; Mortensen et al. 2000; Willette et al. 2001). Therefore, sampling juveniles after the period of high initial mortality may provide information that can be used with associated environmental data to forecast abundance. Wertheimer et al. (2006) found that abundance of juvenile pink salmon from 1997 to 2004 in the strait habitats of the northern region sampled by SECM was highly correlated with the subsequent year’s catch in southeastern Alaska, and had promise as a forecast tool for pink salmon.

The Northern Fund bioenergetics modeling component will attempt to compare the trophic demand of juvenile salmon on prey resources in strait habitats of the two regions of southeastern Alaska. Bioenergetics models will be used to estimate the proportion of zooplankton standing crop consumed by hatchery chum salmon compared to wild juvenile pink and chum salmon in these regions. Several biophysical parameters will be measured and used in the models, including juvenile salmon abundance, diet composition, growth and energy density, zooplankton abundance and composition, and environmental parameters. In particular, stock-specific information from otolith-marked chum salmon will be used to differentiate hatchery from wild stocks.

This document summarizes SECM data collections for 2005. These data include catches of juvenile salmon and ecologically-related species and their associated biophysical oceanographic parameters. We also examine the efficacy of using juvenile pink salmon catch data to forecast regional pink salmon adult returns in 2006, and provide information on the status of laboratory processing of samples to be used for bioenergetics models.

Methods

Up to 17 stations were sampled in four time periods from May to August 2005 (Table 1). Sampling was accomplished, as conditions permitted, by the National Oceanic and Atmospheric Administration (NOAA) ship *John N. Cobb*, a 29-m long research vessel with a main engine of 325 hp and a cruising speed of 10 knots. Stations were located along two primary seaward migration corridors within the Alexander Archipelago, used by juvenile salmon that originate in southeastern Alaska. The northern corridor extends 250 km from inshore waters, along Chatham Strait, Icy Strait, and off Icy Point into the Gulf of Alaska, whereas the southern corridor extends 175 km from upper Clarence Strait to Dixon Entrance near the Gulf of Alaska (Figure 1). At each station, the physical environment, zooplankton, and fish were typically sampled during daylight hours.

In the northern migration corridor, the 13 core sampling stations were selected by 1) the presence of historical time series of biophysical data in the region, 2) the objective of sampling habitats that transition the primary seaward migration corridor used by juvenile salmon, and 3) the operational constraints of the vessel. Sea conditions of waves less than 2.5 m and winds less than 12.5 $m \cdot sec^{-1}$ were usually necessary to operate the sampling gear safely, which particularly influenced sampling opportunities in coastal waters. The inshore station in Auke Bay (ABM) and the four Icy Strait stations were selected initially because historical data exist for them (Bruce et al. 1977; Jaenicke and Celewycz 1994; Landingham et al. 1998; Murphy and Orsi 1999; Murphy et al. 1999; Orsi et al. 1997, 1998, 1999, 2000a and 2000b, 2001a, 2001b, 2002, 2003, 2004b, 2005, 2006). The Chatham Strait stations were selected to intercept juvenile wild stocks and juvenile otolith-marked salmon entering Icy Strait from Alaska enhancement facilities (principally Douglas Island Pink and Chum Hatchery (DIPAC) and Northern Southeast Alaska Regional Aquaculture Association (NSRAA); Figure 1). The Icy Point stations were selected to monitor conditions in the coastal habitat of the Gulf of Alaska. Vessel and sampling gear constraints limited operations to offshore distances between 1.5 km and 65 km, and to bottom depths greater than 75 m; this precluded trawling at ABM (Table 1).

In the southern migration corridor, eight sampling stations were selected in the vicinity of Clarence Strait, located approximately 350 km south of the northern migration corridor, and funneling southward to Dixon Entrance. Several salmon enhancement facilities are operated in this region by the Southern Southeast Alaska Regional Aquaculture Association (SSRAA). Stations were selected along two transects, Middle Clarence Strait and Lower Clarence Strait, to intercept seaward-migrating juvenile wild stocks and juvenile otolith-marked salmon from the southern region (Figure 1).

Oceanographic sampling

Oceanographic data were collected at each station immediately before or after each trawl haul, and consisted of one conductivity-temperature-depth profiler (CTD) cast, one or more vertical plankton hauls with conical nets, and one double oblique plankton haul using a bongo net system. The CTD data were collected with a Sea-Bird[1] SBE 19 Seacat profiler to 200 m or within 10 m of the bottom. Surface (3-m) temperature and salinity data were collected at 1-

[1]Reference to trade names does not imply endorsement by the Auke Bay Laboratory, National Marine Fisheries Service, NOAA Fisheries.

minute intervals with an onboard thermosalinograph (Sea-Bird SBE 21). Surface (bucket) and 20-m (Niskin bottle) water samples were taken once at each station for later nutrient and chlorophyll analysis contracted to the Marine Chemistry Laboratory at the University of Washington School of Oceanography. To quantify ambient light levels, light intensities ($W \cdot m^{-2}$) were recorded at each station with a Li-Cor Model 189 radiometer. To quantify relative water clarity, the CTD was used in lieu of a Secchi disk; depth measurements (m) were made by observing the visual disappearance of the CTD following deployment.

Zooplankton was sampled at all stations with several net types during each month. One shallow vertical haul (20-m) was made at each station (except three at ABM) with a 50-cm, 243-µm mesh NORPAC net. One deep vertical haul (to 200 m or within 10 m of bottom) was made at ABM and the Icy Point stations with a 57-cm, 202-µm mesh WP-2 net (Table 2). One double oblique bongo haul was made at stations along the Icy Strait and Lower Clarence Strait transects and at ABM to a depth of 200 m or within 20 m of the bottom, using a 60-cm diameter tandem frame with 505-µm and 333-µm mesh nets. A VEMCO ML-08-TDR time-depth recorder was used with the oblique bongo hauls to record the maximum sampling depth of each haul. General Oceanics model 2031 or Rigosha flow meters were placed inside the bongo and deep conical nets for calculation of filtered water volumes.

Zooplankton samples were concentrated and preserved in a 5% formalin-seawater solution. In the laboratory, zooplankton settled volumes (ZSV, ml) and total settled volumes (TSV, ml) of each 20-m vertical haul were measured after settling the samples for a 24-hr period in Imhof cones. Mean ZSVs were determined for pooled stations by region, habitat, and month. Displacement volumes (DV, ml) of zooplankton were measured for bongo net samples (333-µm and 505-µm mesh). Samples were brought to a constant volume (500 ml) by adding water, and then were sieved through 243-µm mesh to separate the zooplankton from the liquid. The volume of decanted liquid was measured and subtracted from the sample starting volume to yield zooplankton DV. Standing stock of bongo samples was calculated using DV (ml) divided by the volume of water filtered (m^3) based on flowmeter revolutions per haul. Mean DVs were determined for pooled stations by region, habitat, and month.

Detailed zooplankton species composition was determined microscopically from subsamples obtained using a Folsom or Motoda splitter. Density was then estimated by multiplying the count in the subsample by the split fraction and dividing the expanded count by the volume filtered. Percent total composition was summarized by major taxa for region, habitat, and month. Species were pooled into taxonomic groups including small calanoid copepods (≤ 2.5 mm TL), large calanoid copepods (> 2.5 mm TL), barnacle larvae, euphausiids (principally larval and juvenile stages), oikopleurans (Larvacea), decapod (crab) larvae, amphipods (hyperiid and gammarid), gastropods (primarily pteropods), chaetognaths, and combined minor taxa. Laboratory processing is ongoing. Detailed data summarized in this report include ZSVs of NORPAC samples from all locations (n = 115), DV and standing stock of 333- and 505-µm bongo samples from strait habitat in the southern and northern regions (n = 48), and density and taxonomic composition of 333-µm bongo samples (n = 24) from strait habitat in the two regions.

Fish sampling

Fish sampling was accomplished with a Nordic 264 rope trawl modified to fish the surface water directly astern of the *John N. Cobb*. The trawl was 184 m long and had a mouth opening of 24 m by 30 m (depth by width). A pair of 3-m foam-filled Lite trawl doors, each weighing 544 kg (91 kg submerged), was used to spread the trawl open. Earlier gear trials with this vessel and trawl indicated the actual fishing dimensions of the trawl to be 18 m deep (head rope to foot rope) by 24 m wide (wingtip to wingtip), with a spread between the trawl doors ranging from 52 m to 60 m (Orsi et al., unpubl. cruise report 1996). Trawl mesh sizes from the jib lines aft to the cod end were 162.6 cm, 81.3 cm, 40.6 cm, 20.3 cm, 12.7 cm, and 10.1 cm over the 129.6-m meshed length of the rope trawl. A 6.1-m long, 0.8-cm knotless liner mesh was sewn into the cod end. The trawl also contained a small mesh panel of 10.2-cm mesh sewn along the jib lines on the top panel between the head rope and the 162.6-cm mesh to reduce loss of small fish. To keep the trawl headrope at the surface, a cluster of three A-4 Polyform buoys, each encased in a knotted mesh bag, was tethered to each wingtip of the headrope, and one A-3 Polyform float was clipped onto the center of the headrope. The trawl was fished with 137 m of 1.6-cm wire main warp attached to each door and three 55-m (two 1.0-cm and one 1.3-cm) wire bridles.

For each haul, the trawl was fished across a station for 20 min at about 1.5 m · sec^{-1} (3 knots), covering approximately 1.9 km (1.0 nautical mile). Station coordinates were targeted as the midpoint of the trawl haul; however, current, swell, and wind conditions dictated the direction in which the trawl was set. Trawling effort in the strait habitat was standardized to three replications of the primary transects (Icy Strait and Lower Clarence Strait) and two replications of the secondary transects (Upper Chatham Strait and Middle Clarence Strait). Replications were done to ensure that sufficient samples of marked juvenile salmon were obtained for regional and interannual comparisons, and to obtain a better index of CPUE variability. Minimal oceanographic sampling was conducted during replicate trawls.

After each trawl haul, the fish were anesthetized with tricaine methanesulfonate (MS-222), identified, enumerated, measured, labeled, bagged, and frozen. After the catch was sorted, fish and squid were measured to the nearest mm fork length (FL) or mantle length with a Limnoterra FMB IV electronic measuring board (Chaput et al. 1992). Jellyfish (gelatinous species) retained in trawl hauls were volumetrically measured to the nearest 0.5 L and identified to genus. Usually all fish and squid were measured, but very large catches were subsampled due to processing time constraints. Up to 60 juvenile salmon of each species were bagged individually; the remainder was bagged in bulk. All fish were frozen immediately after measurement. During times of extended processing, fish were chilled with ice packs to minimize tissue decomposition and gastric activity. All Chinook and coho salmon were examined for missing adipose fins that would indicate the possible presence of implanted CWTs; those with adipose fins intact were again screened with a detector in the laboratory. The snouts of these fish were dissected in the laboratory to recover CWTs, which were then decoded and verified to determine fish origin. Catches were summarized by species, region, month, and habitat. For juvenile salmon, CPUE was calculated as the mean number of fish per trawl haul.

Juvenile pink and chum salmon were retained to examine diets from preserved samples and energy density from frozen samples in concordance with the Northern Fund project objectives. Juvenile salmon diet, energy density, and growth information will be used with zooplankton abundance and temperature data to compare trophic interactions and perform bioenergetics modeling of juvenile salmon between the northern and southern regions of southeastern Alaska in June and July. Sampling protocols were to collect 30-60 frozen chum salmon and 15 frozen pink salmon for energy studies and 30-60 preserved chum salmon and 15 preserved pink salmon for diet studies at each station, to maximize the possibility of obtaining at least ten specimens per transect-month-species-stock stratum. When too few specimens were available at a station, samples were prioritized for freezing from the first trawl and for preserving in 10% formalin-seawater solution from subsequent trawls at that station. Preserved fish were transferred to 50% isopropyl alcohol one week after fixation in formalin to minimize deterioration of the calcareous otoliths.

Frozen individual juvenile salmon were weighed in the laboratory to the nearest 0.1 gram (g). Mean lengths, weights, and Fulton condition factors ($g \cdot mm^{-3} \cdot 10^5$; Cone 1989) were computed for each species by habitat and sampling interval. Preserved fish were also weighed and measured. To identify stock of origin of juvenile chum, sockeye, coho, and Chinook salmon, the sagittal otoliths were extracted from the crania and preserved in 95% ethyl alcohol. Excess frozen chum salmon from replicate hauls at stations with abundant catches were not processed. All preserved chum salmon were processed for stock composition data from otolith thermal marks. Laboratory processing of otoliths for thermal marks was contracted to DIPAC. Otoliths were prepared for microscopic examination of potential thermal marks by mounting them on slides and grinding them down to the primordia (Secor et al. 1992). Ambiguous otolith thermal marks were verified by personnel at the ADFG otolith laboratory. Stock composition (percent number) and growth trajectories (change in apparent growth) of thermally marked fish were determined for each region, month, and habitat.

Data on stock composition of chum salmon available from analysis of otolith thermal marks were used to select subsamples of fish stock groups and species co-occurring by region, location, and month. Processing of energy and diet samples was underway at the time of this report. For energy density analyses, frozen fish were measured and weighed as above, stomachs were excised, stomach contents were extracted and weighed, and viscera were replaced in the body cavity. The entire carcass was dried to a constant weight (nearest mg), homogenized into uniform powder, and a pellet sub-sample (~ 0.150 g) was pressed; the pellet was then combusted in a Parr 14251 bomb calorimeter (Parr Inst. Co. 1993) and the energy released recorded as calories per g dry weight ($cal \cdot g^{-1}$ DW). Percent DW was calculated and used to convert energy units to cal g wet weight ($cal \cdot g^{-1}$ WW). For diet analyses, preserved fish were measured and weighed as above and stomachs were excised, weighed (nearest mg WW), and stored in 50% isopropyl alcohol. Stomach fullness and prey digestion indices, stomach content weight, and prey composition and numbers were estimated microscopically following Sturdevant et al. (2002). Diet parameters calculated include stomach mean fullness index (% fullness), prey percent body weight (%BW, stomach content wet weight divided by fish body weight without stomach contents), mean total numbers and weights of total prey, and mean percent numbers (%N), percent weights (%W), and percent frequency of occurrence (%FO) of major prey taxa. Energy and diet parameters will be summarized and compared by region, month, species, and stock groups.

Potential predators of juvenile salmon from each haul were identified, measured, and weighed onboard the vessel. Their stomachs were excised, weighed, and classified by percent fullness (nearest 10%). Stomach contents were removed, empty stomachs weighed, and total content weight determined by subtraction. General prey composition was determined by estimating contribution of major taxa to the nearest 10% of total volume. The wet-weight contribution of each prey taxon to the diets was then calculated by multiplying its percent volume by the total content weight. Fish prey was identified to species, if possible, and lengths were estimated. The incidence of predation on juvenile salmon was computed for each potential predator species. Overall diets were summarized by percent weight of major prey taxa and the frequency of feeding fish.

Forecasting Pink Salmon Abundance

We examined three measures of juvenile pink salmon CPUE at the strait stations (Icy Strait and Upper Chatham Strait) in the northern region and eight concurrent biophysical parameters in year y over the years 1997-2004 for bivariate correlation with the annual commercial harvest of pink salmon in southeastern Alaska in year y +1. The three measures of juvenile CPUE were 1) Peak CPUE, the average Ln (CPUE+1) for catches for the month that had the highest average catches in a given year; 2) JJ-Avg (CPUE), the mean of the average Ln (CPUE+1) for June and July; and 3) JJA-Avg (CPUE), the mean of the average Ln (CPUE+1) for June, July, and August. The eight biophysical parameters included May 3-m and July 3-m average temperatures; July 3-m average salinity; May and June average NORPAC 20-m SV and May and June average 333-bongo DV as indexes of upper water column zooplankton; apparent growth of juvenile pink salmon in terms of change in average lengths from June to July cruises; a weighted average size of juvenile pink salmon, adjusted to July 22; and the number of hatchery chum salmon juveniles released in the northern region of southeastern Alaska inside waters. We obtained associated pink salmon harvest data from the ADFG (ADFG 2006). We assumed that harvest was proportional to total run. We tested that assumption by examining the relationship between harvest and the southeastern Alaska total escapement index count (personal communication, Steve Heinl, ADFG), with the understanding that the escapement index data has large potential measurement error (Plotnick and Eggers 2004). We constructed regression models considering each of the three CPUE measures separately, with harvest as the dependent variable, using forward-backward stepwise regression (Minitab 2000) to determine which, if any, of the biophysical parameters significantly improved model fit. A parameter had to be significant at $P <$ 0.1 to be added or to remain in the stepwise model. We then used the appropriate 2005 juvenile pink salmon CPUE data to forecast harvest in 2006.

To incorporate the effect of measurement error on the confidence intervals (CI) of the forecast models, we developed bootstrap confidence intervals for each forecast model. We randomly re-sampled catches for each month in each year y n_{my} times, where n is the number of hauls in month m in year y, and then we averaged the re-sampled catches for each month and year. These average simulated catches for years 1997-2004 were used to construct the regression models with southeastern Alaska harvest as the dependent variable, and the appropriate averages of the simulated catches for 2005 were used to forecast 2006 harvests. This process was repeated 1000 times, generating 1000 forecasts for each model. The forecasts were ordered from lowest to highest, and the lowest 10% and highest 10% were removed to define the 80% bootstrap CIs.

Results and Discussion

During the four month (40-d) survey in 2005, data were collected from 92 rope trawl hauls, 112 CTD casts, 128 bongo net samples (double oblique, tandem 333-µm and 505-µm nets hauled from ≤200 m depths), 136 conical net hauls (115 NORPAC, 243-µm nets hauled from 20 m depths and 8 WP-2, 202-µm nets hauled from ≤200 m depths), and 105 surface water samples (Table 2). The sampling periods occurred near the ends of each month from May to August in the northern region and in June and July in the southern region. Samples were relatively synoptic between regions, all within a nine day time period each month. Oceanographic sampling was completed at all stations from May to August. Rope trawling occurred in strait localities of both regions in June and July, and in August in the northern region.

Oceanography

Surface (3-m) temperatures ranged from 9.3 to 15.7 ºC over the season in the two regions of southeastern Alaska (Table 3). In the northern region, surface temperatures followed similar seasonal patterns among habitats (Figure 2a). In inshore and strait habitats, surface temperatures increased by 3-8 ºC between May and June then declined by 1-2 ºC in July and August. Between regions, surface temperatures in strait habitats were similar in June, but in July, temperature was 2 ºC higher in the southern region than in the northern region.

Surface salinities ranged from 13.8 to 31.5 PSU over the season in the two regions (Table 3). In the northern region, surface salinity followed different seasonal patterns among habitats. Surface salinities in inshore and strait habitats were similar in June and July, but were lower in the inshore habitat than in the strait habitat in both May and August. Between regions, surface salinities in both strait habitats declined from June to July; however, salinities were 5-10 PSU higher in the southern region (Figure 2b).

A total of 103 water samples were taken across the 17 stations over the course of the season (Tables 2 and 4). Both surface and 20-m samples were collected at each station in all months except August, when no 20-m samples were taken. For surface water samples overall, nutrient concentration ranges and means were 0.00-1.39 and 0.29 µM for PO_4, 0.00-31.33 and 6.20 µM for $Si(OH)_4$, 0.00-18.31 and 1.74 µM for NO_3, 0.00-0.26 and 0.04 µM for NO_2, and 0.13-2.01 and 0.75 µM for NH_4. Chlorophyll ranged from 0.25 to 4.81 mg · m^{-3} with a mean of 1.56 mg · m^{-3}, and phaeopigment concentrations ranged from 0.06 to 7.30 mg · m^{-3} with a mean of 0.29 mg · m^{-3} (Table 4). For 20-m water samples overall, nutrient concentration ranges and means across the 17 stations were 0.41-1.88 and 1.00 µM for PO_4, 3.08-40.29 and 19.96 µM for $Si(OH)_4$, 2.01-19.30 and 10.64 µM for NO_3, 0.04-0.40 and 0.19 µM for NO_2, and 0.00-4.43 and 1.65 µM for NH_4. Chlorophyll ranged from 0.12-3.47 mg · m^{-3} with a mean of 1.03 mg · m^{-3}, and phaeopigment concentrations ranged from 0.06-1.33 mg · m^{-3} with a mean of 0.59 mg · m^{-3} (Table 4). In June and July, for synoptic surface and 20-m water samples taken in strait habitats in both regions, chlorophyll concentrations were higher at the surface, while nutrient and phaeopigment concentrations were higher at the 20-m depth.

During the June-July period of trawling in the northern and southern regions, 83 measurements of ambient light intensity and water clarity were taken at 16 trawl stations, all in daylight (0720-1832 h). Overall, ambient light intensity ranged from 21 to 1,050 W · m^{-2} and water clarity depths ranged from 3 to 6 m. Mean light intensities were 201 and 398 W · m^{-2} in the northern and southern regions. Mean water clarity depth measurements were 3.8 and 4.8 m in the northern and southern regions.

Zooplankton mean settled volumes (ZSV) ranged from 2.0-28.3 ml in NORPAC 20-m vertical hauls (Table 5). Seasonal patterns of ZSV were weak and differed among habitats (Table 5; Figure 2c). In the northern region, ZSV was similar between habitats from May to July; in August, however, ZSV increased in the inshore habitat and decreased in the strait habitat. ZSV was similar between regions in June, but increased in the northern region and decreased in the southern region in July. Qualitative, visual examination of NORPAC samples indicated a wide diversity of mesozooplankton taxa and slub present, but no discreet layers of phytoplankton were discernible. Detailed microscopic analysis for regional estimates of zooplankton species composition and density was in progress at the time of this report.

Zooplankton collected in bongo nets varied seasonally, between habitats and regions, and between mesh sizes (Table 6; Figures 3 and 4). Zooplankton standing stock ranged from 0.1 to1.6 ml · m^{-3} in 333-µm mesh and from 0.1 to 1.2 ml · m^{-3} in 505-µm mesh (Table 6). In the northern region, zooplankton standing stock declined seasonally in Icy Strait for both mesh sizes, while patterns varied for Auke Bay (Figure 3a, b). Zooplankton standing stock was greater in Icy Strait than in the inshore habitat of Auke Bay. Between regions, zooplankton standing stock in strait habitat was twice as high in the northern as in the southern region (Figure 3a, b).

Zooplankton abundance (number · m^{-3}) in the strait habitat followed similar patterns as zooplankton standing stock from 333-µm mesh (Figure 4a). In Icy Strait, seasonal abundance dropped by nearly 50% from May to August, from a mean of approximately 1,193 to 654 total zooplankters per cubic meter. Between regions, mean zooplankton densities were 3-4 times greater in Icy Strait than in Lower Clarence Strait, approximately 939 vs. 366 · m^{-3} in June and 816 vs. 233 · m^{-3} in July (Figure 4a). Nevertheless, principal taxonomic composition was very similar between regions, with small calanoid copepods constituting 58-67% and large calanoids constituting 9-28% of total organisms present (Figure 4b, c).

Catch composition

A total of 6,874 fish and squid, representing 19 taxa, were captured in 92 rope trawl hauls in the northern and southern regions of southeastern Alaska from June to August (Tables 7 and 8). Juvenile salmon comprised 96% of the total fish and squid catch in each region. Juvenile salmon occurred frequently in both regions, with pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), and coho (*O. kisutch*) occurring in 63-86% of the trawl hauls, and juvenile Chinook salmon occurring in 20-25% of the trawl hauls (Tables 9 and 10, Figure 5). Of the 6,651 salmon caught, over 99% were juveniles. Catches and life history stages of the salmon are listed by date, haul number, and station in Appendix 1. In both regions, only two non-salmonid species represented >1% of the catch: market squid (*Loligo* spp.) in the southern region (2%) and crested sculpin (*Blepsias bilobus*) in the northern region (2%).

Temporal and spatial differences were observed in the catch, size, condition, and stock of origin of juvenile salmon species. For catch, the CPUEs of juvenile salmon were highest in June for all species except pink salmon, which had the highest CPUE in August (Figure 6). A seasonal peak CPUE in August for juvenile pink salmon has never been documented during the previous eight years of study. In the northern region, where sampling extended until August, catch per haul increased from July to August for all species except Chinook salmon.

Size and condition of juvenile salmon differed among the species and sampling periods (Tables 11-15; Figures 7-9). Juvenile coho and Chinook salmon were consistently 25-100 mm longer than sockeye, chum, and pink salmon in a given time period. Most species increased in both length and weight in successive time periods, indicating growth despite the influx of additional stocks with varied times of saltwater entry. Overall, mean FLs of juvenile salmon in June, July, and August were: 92.3, 127.3, and 170.4 mm for pink; 108.3, 124.3, and 190.6 mm for chum; 114.7, 122.6, and 180.4 mm for sockeye; 183.8, 207.0, and 238.8 mm for coho; and 204.9, 244.5, and 255.0 for Chinook salmon. Overall, mean weights of juvenile salmon in June, July, and August were: 8.3, 19.6, and 51.1 g for pink; 11.7, 18.6, and 78.7 g for chum; 15.8, 20.1, and 62.7 g for sockeye; 76.3, 109.2, and 167.2 g for coho; and 97.7, 191.2, and 223.1 g for Chinook salmon. Overall, mean condition factor values for juvenile salmon in June, July, and August were: 0.9, 0.9, and 1.0 for pink; 1.0, 0.9, and 1.1 for chum; 1.0, 1.0, and 1.1 for sockeye; 1.2, 1.2, and 1.2 for coho; and 1.2, 1.4, and 1.3 for Chinook salmon. Condition factor generally increased seasonally; mean values near 1.0 indicated healthy feeding environments.

Pacific salmon from Alaskan and Pacific Northwest stock groups were represented in the SECM trawl catches throughout southeastern Alaska, from both CWT-tagged and otolith-marked salmon released by enhancement agencies. Acronyms and abbreviations for the many agencies and facilities from which enhanced species and stock-groups were released are shown in Table 16.

Twenty-five of the 64 juvenile and immature salmon lacking adipose fins contained CWTs (Table 16). The CWTs were recovered from 17 juvenile coho, 6 juvenile Chinook, and 2 immature Chinook salmon; all but 6 of these fish were from hatchery and wild stocks of southeastern Alaska origin. The tagged Alaska wild stocks were represented by coho salmon from Auke Creek, Berners River, Chilkat River, and Taku River. The tagged Alaska hatchery stocks were represented by coho salmon from Herring Cove, Indian River, Kasnyku Bay, Nakat Inlet, Neets Bay, and Sheep Creek. The Alaska hatchery Chinook salmon stocks were represented by Blind Slough, Fish Creek, Kasnyku Bay, Little Port Walter, and Port Armstrong. The non-Alaska stocks were juvenile coho and Chinook salmon recovered in the southern region in June and July. The non-Alaska stocks of juvenile coho salmon originated from Big Creek, Oregon, and the Clearwater River, Chehalis River, and Willapa Bay in Washington; most fish had migrated 1,200-1,500 km in a period of about two months. The non-Alaska stocks of juvenile Chinook salmon were stream-type fish from the Deschutes and Willamette rivers in Oregon; most of these fish had migrated 1,100-1,700 km in a period of two to three months. Tags were absent from an extremely high proportion of adipose-clipped juvenile coho (68%, 36 of 53) and Chinook salmon (43%, 3 of 7). These fish were primarily found in the southern region and suggest that most were of hatchery origin from southerly release localities, where hatcheries are mandated to remove the adipose fin of all salmon they produce.

In addition to the CWT information on stock of origin, stock-specific information was obtained from otolith-marked, enhanced salmon recovered in both regions (Tables 17-20, Figures 10-13). Examination of thermal marks enabled stock information to be obtained from species such as chum and sockeye salmon that normally are not tagged with a CWT, yet contribute a major proportion to the total enhancement component in southeastern Alaska. Captured chum salmon stocks include seven DIPAC stock groups, three NSRAA stock groups, and six SSRAA stock groups. DIPAC stock groups included marked fish from Amalga Harbor early regular (ER) and late large (LL) release groups, Boat Harbor, Gastineau ER and LL release groups, and Limestone Harbor. NSRAA stocks included Kasnyku Bay ER and LL, and Takatz Bay release groups. SSRAA stock groups included fish released from Anita Bay summer stocks, Kendrick Bay summer stocks, Nakat Inlet fall and summer stocks, and Neets Bay fall and summer stocks. The principal hatcheries in the region each uniquely mark nearly 100% of their chum salmon releases. For sockeye salmon, only DIPAC facilities released fish, including groups from Port Snettisham, Tahltan Lake, and Tatsemenie Lake.

For juvenile chum salmon, stock-specific information was derived from the otoliths of a subsample of 983 fish, representing 36% of those caught (Figure 10). These fish were the same individuals sampled for weight and condition (Table 17). Of all chum salmon otoliths examined, 469 (53%) were marked: 162 (18%) were from DIPAC, 160 (18%) were from NSRAA, and 147 (17%) were from SSRAA releases. The remaining 469 (47%) of chum salmon examined were unmarked and probably included both wild stocks and unmarked hatchery stocks from southern release localities.

Chum salmon stock composition based on otolith marks differed by region. In the northern region, stocks from all three major enhancement facilities were captured in varying monthly proportions. Overall, hatchery composition declined in the northern region from 75 to 25% between June and August, when 339, 66, and 95 juvenile chum salmon were examined, respectively. DIPAC stocks were most prominent in June, NSRAA stocks were most prominent in July, and SSRAA stocks were present only in August. Of all juvenile chum salmon examined, DIPAC stocks comprised 41% in June, 5% in July, and 15% in August. NSRAA chum salmon stocks comprised 33% in June, 38% in July, and 29% in August. Two SSRAA chum salmon stocks were recovered in the northern region and comprised about 5% of the catch in August (*n* = 3 each from Neets Bay and Kendrick Bay). In the southern region, only the SSRAA chum salmon stocks were captured; they comprised a little over 50% in both June (*n* = 309) and July (*n* = 94; Table 17, Figure 10).

For juvenile sockeye salmon, stock-specific information was derived from the otoliths of 387 fish, representing 100% of those caught (Figure 11). These fish were the same individuals sampled for weight and condition (Table 18). Of all the sockeye salmon otoliths examined, 18% (*n* = 69) were marked and originated from three stock groups released by DIPAC: 12% (*n* = 45) were from Snettisham Hatchery (SH), Alaska, 4% (*n* = 16) were from Tatsamenie Lake, Taku River, British Columbia, and 2% (*n* = 8) were from Tahltan Lake, Stikine River, British Columbia. The remaining 316 sockeye salmon (82%) examined were unmarked and were presumably from wild stocks.

Sockeye salmon stock composition based on otolith marks differed by region. In the northern region, hatchery composition varied from approximately 20-30% of the sockeye caught each month (*n* = 173, 25, and 15 in June, July, and August, respectively). Snettisham stocks comprised the principal hatchery component (*n* = 38, 3, and 4 in June, July and August, respectively). Among other sockeye salmon stocks recovered in the northern region, Tatsamenie Lake fish were present in June (*n* = 15) and July (*n* = 1), and a small fraction of Tahltan Lake fish were present in June (*n* = 5). Few sockeye salmon of hatchery origin were caught in the southern region. In June, of 153 juvenile sockeye salmon caught on both transects, only 3 were from Tahltan Lake, while in July, none of 19 juvenile sockeye caught were marked (Table 18, Figure 11).

For juvenile coho salmon, stock-specific information was derived from the otoliths of 624 fish, representing 97% of those caught (Figure 12). These fish were the same individuals sampled for weight and condition (Table 19). Of all the coho salmon otoliths examined, 25 (9%) were marked and originated from two stock groups: 3% (*n* = 19) were from DIPAC and 1% (*n* = 5) were from NSRAA's Medvejie Hatchery (MH). The remaining 600 (96%) coho salmon examined were unmarked and included both wild stocks and possibly unmarked hatchery stocks from southern release localities.

Coho salmon stock composition based on otolith marks differed by region. In the northern region, of the 257, 101, and 43 juvenile coho salmon caught in June, July and August, respectively, hatchery stocks contributed 5-10% in all months. In the southern region, no hatchery stocks were represented in the 174 and 49 juvenile coho salmon that were caught in June and July, respectively (Figure 12).

For juvenile Chinook salmon, stock-specific information was derived from the otoliths of 18 fish, representing 72% of all 25 fish caught (Figure 13) and sampled for weight and condition (Table 20). In the northern region, juvenile Chinook salmon were examined from June, July and August (n = 7, 4, and 1). In the southern region, five were examined from June and one was examined from July. Of all the Chinook salmon otoliths examined, nine (50%) were marked; all of these originated from NSRAA's MH and were caught in the northern region in June and July (Figure 13). No otolith-marked juvenile Chinook salmon were caught in the southern region. The remaining nine (50%) Chinook salmon examined were unmarked and included both wild stocks and possible unmarked hatchery stocks from southern release localities.

Monthly samples of thermally marked juvenile chum, sockeye, coho, and Chinook salmon were used to construct stock-specific apparent growth trajectories. Weights of juvenile salmon from marked stocks were compared to weights of unmarked stocks (Figures 14 and 15). The marked chum salmon stocks included pooled release groups from DIPAC (seven groups), NSRAA (three groups), and SSRAA (six groups). The marked coho salmon included NSRAA Medvejie Hatchery releases. The marked sockeye salmon stocks included hatchery stock groups from Snettisham (four groups) and two wild stocks. These salmon were released in 2005 at the following approximate dates and size ranges: chum in April-May (1-4 g); sockeye in April-June (5-10 g); coho in May-June (15-23 g); and Chinook in May-July (9-59 g). Stock-specific size of salmon increased monthly for all groups (Figures 14 and 15). For most individual stock size and growth information, refer to Tables 17-20.

Jellyfish biomass and species composition retained in trawl catches also varied between the two regions of southeastern Alaska. In June, the "clear" jellyfish *Aequoria* sp. and *Aurelia* sp. were abundant in trawls in the southern region, while low jellyfish biomass was retained in trawls in the northern region. In July, these species were about half as abundant in the southern region, and *Cyanea* sp. became conspicuous in the northern region. Also conspicuous in July were the ichthyofauna associated with these large jellyfish, the prowfish (*Zaprora silenus*), crested sculpin, and young-of-the-year walleye pollock (Figure 16).

Onboard stomach analysis was conducted on 63 potential predators, representing eight species (Table 21). In the southern region, they included 6 and 18 specimens in June and July, while in the northern region, they included 10, 24, and 5 specimens in June, July, and August, respectively. Sizes of potential predators and stomach fullness are presented in Table 22. Only one predation incident on juvenile salmon was observed. A juvenile pink salmon (90 mm FL) was consumed by a spiny dogfish (*Squalus acanthias*) caught in Middle Clarence Strait in the southern region in June (Figure 17). The juvenile salmon constituted only 3% of the total prey biomass consumed by all nine spiny dogfish caught; the majority of dogfish prey was cephalopods, primarily squid. The other most common potential predators included adult pink salmon and immature Chinook salmon. Adult pink salmon were planktivorous in both regions, consuming primarily crab larvae in the southern region and a mixture of fish, crab larvae, and pteropods in the northern region. Immature Chinook salmon were principally piscivorous in both regions; prey included fish larvae, herring, smelt, sandlance, sticklebacks, and unidentified fish remains. A few adult chum and coho salmon were also caught in both regions. For chum salmon, the single specimen from the southern region had consumed only crab larvae, while the three from the northern region had consumed principally oikopleurans (Larvacea). For the two adult coho salmon caught, diets were composed of fish (herring) in the southern region and euphausiids in the northern region (Figure 17). Overall, too few predators were examined to reach conclusions about regional differences in overall diet or rates of predation on juvenile salmon.

Diet (preserved) and energy (frozen) samples of juvenile chum salmon stock groups and juvenile pink salmon were successfully collected for regional comparisons of trophic interactions and bioenergetics parameters in June and July. The subsamples selected for energy and diet studies are shown in Tables 23 and 24, while all station-specific catches for each species are shown in Appendix 1. Field sample collections were sufficient to provide diet and energy samples representing each stock by region, but were not sufficient to represent all stocks at the finer resolutions of transect, station, or diel period. Diet and energy samples from all stocks were available from at least two stations on each transect in June, during peak abundance; stocks were less well-represented from July samples, when catches declined. From the northern region, we selected samples representing the feeding habits and energetic condition of seven DIPAC stock groups (Amalga Harbor ER and LL, Boat Harbor, Gastineau ER and LL, and Limestone) and three NSRAA stock groups (Kasnyku ER and LL and Takatz), as well as unmarked (presumably wild) pink and chum salmon. In June, northern diet samples included 192 chum and 18 pink salmon and energy samples included 165 chum and 20 pink salmon; in July, northern diet samples included 33 chum and 22 pink salmon and energy samples included 45 chum and 18 pink salmon (Table 23). From the southern region, we selected samples representing six SSRAA hatchery stock groups as well as unmarked, presumably wild, juvenile pink and chum salmon. These juvenile chum salmon stocks included fish released from Anita Bay, Kendrick Bay, Nakat Inlet fall and summer stocks, and Neets Bay fall and summer stocks. In June, southern diet samples included 151chum and 20 pink salmon and energy samples included 150 chum and 20 pink salmon; in July, southern diet samples included 39 chum and 17 pink salmon and energy samples included 54 chum and 15 pink salmon (Table 24). Laboratory analysis of these field samples for both diet and energy density was ongoing at the time of this report.

In addition to field caught samples, “voucher” specimens from hatchery net pen releases in select localities were obtained from DIPAC, NSRAA, and SSRAA facilities, and will provide initial energy density values for samples of these stocks recovered up to three months later. Hatchery voucher samples already processed (data not shown) included three NSRAA releases (n = 35 total from Kasnyku ER and LL and Takatz), six SSRAA releases (n = 65 total from Anita Bay, Kendrick Bay, Nakat Inlet fall and summer stocks, and Neets Bay fall and summer stocks), and five DIPAC releases (n = 50 total from Amalga LL, Boat Harbor LL, Gastineau LL at two rearing locations, and Limestone ER).

Forecasting Pink Salmon Abundance

Previous pre-season forecasts for 2004 and 2005 from the regression models developed from juvenile CPUE data indicated that both Peak CPUE and JJ-Avg CPUE provided reasonable estimates of subsequent year-class returns (Table 25). For all the forecast models evaluated, the actual harvests in 2004 and 2005 were within the 80% prediction confidence intervals. The Peak CPUE forecasts deviated from the estimated actual harvests in 2004 and 2005 by 0.2% and 3.8%, and the JJ-Avg forecast by 9.7% and 10.3%, respectively. The ADFG model also performed well for 2004 and 2005, deviating from the actual harvests by 10.4% and 17.2%, respectively (Table 26).

Catches of juvenile pink salmon were higher in August of 2005 in strait habitats of the northern region, the only time this has occurred in the nine-year time series (Figure 18). Because August catches in prior years had been low, we had assumed that most juvenile pink salmon had migrated from the strait habitats of the northern region by August, and we had not considered August CPUE for the forecasting models. The anomalously high August catches in 2005 may have been due to high near-surface water temperatures affecting juvenile salmon distribution; May temperatures (Figure 2a) were the highest recorded during SECM sampling for that time period, and the May-June-July average temperature was also the highest it has been for the SECM time series. We evaluated the effect of the high August catches on the prediction models by 1) incorporating August catches into a seasonal average for each year, JJA-CPUE; and 2) developing forecasts with the Peak CPUE model with and without inclusion of the August peak catches.

Measures of CPUE from 1997-2004 juvenile pink salmon catches in the strait habitats of the northern region were highly and significantly correlated with the subsequent year's pink salmon harvest (Table 25). Correlations for CPUE parameters evaluated ranged from 0.81 for JJ-Avg to 0.93 for Peak. None of the other biophysical parameters measured during the juvenile year were significantly correlated with the subsequent year's harvest.

Stepwise regression analysis indicated that one-parameter CPUE regression models provided the best fit to the southeastern Alaska pink salmon harvest data from 1998-2005, considering juvenile pink salmon CPUE and associated biophysical parameters in Table 25 as predictor variables. All three juvenile CPUE parameters provided statistically significant fits to the harvest data (Table 27). The Peak CPUE model provided the best fit, explaining 85% of the variability in harvest over the SECM time series.

Predictions for the 2006 southeastern Alaska pink salmon harvests using 2005 juvenile CPUE data were very different if August CPUE was incorporated into the forecast (Table 26). Point estimates without using August data ranged from 35 million fish for the Peak CPUE model to 41 million fish for the JJ-Avg CPUE model, whereas with August data the estimates were 54 million for the Peak CPUE and 55 million for the JJA-Avg CPUE.

Bootstrap confidence intervals were narrower than the parametric regression prediction intervals for each of the four CPUE forecasts (Figure 19). We observed little bootstrap bias; the average bootstrap predictions were similar to the point estimate of the regression models (Figure 18).

Total index escapement counts and southeastern Alaska pink salmon harvests were significantly ($P < 0.003$) correlated, with a correlation coefficient $r = 0.89$ (Figure 20). However, residuals between the trend line and annual escapement counts could be indicative of differences in annual exploitation rates. To evaluate the effect of such variation on the forecasts, we used the average annual ratio of harvest to escapement as a weighting factor for the annual total escapement count, and summed the weighted escapement count with the annual harvest to create an estimate of total run (Table 28). This weighting is the equivalent of assuming a 50% average exploitation rate on southeastern Alaska pink salmon; low annual ratios of harvest to index count thus would represent low exploitation rate, and are weighted accordingly. We then used total run instead of harvest as the dependent variable in the CPUE regression models to forecast 2006 total returns, and applied a 50% average exploitation rate to predict 2006 harvest. However, because much of this total run index is based on harvest, the correlation between the total run index and harvest is very high ($r = 0.98$; $P < 0.001$). As a result, the forecasts for 2006 harvest incorporating escapement data were nearly identical as the forecasts using harvest data alone (Table 29).

Pink salmon harvests to southeastern Alaska in 2006 were very poor; preliminary estimates were about 11.4 million fish, the lowest harvest since 1988. The harvest was well below the lower end of the 80% CIs of the predictions for the juvenile CPUE models and the ADFG forecast model (Table 26). The juvenile CPUE models that did not incorporate the high August catches in 2005 in the predictor variable did best. Both the Peak CPUE model without August and the JJ-Avg CPUE model had indicated that catches would be lower in 2006 relative to 2004 or 2005, but still grossly overestimated actual catch.

The poor performance of the predictions using the high August juvenile samples suggest that the anomalous distribution of juvenile pink salmon in 2005 may have been indicative of adverse conditions associated with poor survival, rather than high annual abundance. Conversely, the poor performance of the CPUE models in general may indicate that variable overwinter mortality after migration from the inside coastal waters may determine year-class strength (Beamish and Mahnken 2001; Moss et al. 2005). Periodic high mortality events at this stage would not be reflected by the juvenile CPUE in the strait habitat.

Juvenile CPUE prediction models using SECM data performed very well for the 2004 and 2005 harvest years, but very poorly for the 2006 return. We will reconstruct the juvenile CPUE models incorporating the 2005 juvenile data and the 2006 harvest and escapement data. We will reexamine associated environmental conditions in 2006, including also an index of winter conditions in the Gulf of Alaska (e.g., Pacific Decadal Oscillation winter index). For the 2007 forecasts, we will also consider August CPUE as an auxiliary model parameter that could be indicative of delayed migration or anomalous distribution.

In the past nine years, coastal monitoring in southeastern Alaska has shown both similar and contrasting patterns with respect to the temporal and spatial occurrence of biophysical data from prior years. A common annual pattern of seasonality existed in surface temperatures and salinity levels, which increased progressively westward from inshore to coastal habitats; however, coastal sampling this year was restricted to May. The coastal monitoring of stations in the northern and southern regions of southeastern Alaska is currently ongoing; in 2006, stations in strait habitats of both regions were sampled in June and July, while the northern region was additionally sampled in May and August. Long-term ecological monitoring of key juvenile salmon stocks, in concert with ocean sampling programs that measure appropriate biophysical parameters across adequate spatial and temporal scales, is needed to better understand use of marine habitats, growth, species interactions, and hatchery stock interactions that affect year-class strength in dynamic marine ecosystems.

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Literature Cited

ADFG. 2006. Salmon fisheries harvest statistics. Alaska Department of Fish and Game. Available at http://www.cf.adfg.state.ak.us.

Beamish, R. J. (editor). 1995. Climate change and northern fish populations. Can. Spec. Publ. Fish. Aquat. Sci. 121. 739 p.

Beamish, R. J. and C. Mahnken. 2001. A critical size and period hypotheses to explain natural regulation of salmon abundance and the linkage to climate and climate change. Progress in Oceanography 49:423-437.

Brodeur, R. D., E. A. Daly, M. V. Sturdevant, T. W. Miller, J. H. Moss, M. Thiess, M. Trudel, L. A. Weitkamp, J. Armstrong, and E. C. Norton. In press. Regional comparisons of juvenile salmon (*Oncorhynchus* spp.) feeding in coastal marine waters off the west coast of North America. Proceedings of the American Fisheries Society Symposium, Anchorage AK, September 2005.

Bruce, H. E., D. R. McLain, and B. L. Wing. 1977. Annual physical and chemical oceanographic cycles of Auke Bay, southeastern Alaska. NOAA Tech. Rep. NMFS SSRF-712. 11 p.

Chaput, G. J., C. H. LeBlanc, and C. Bourque. 1992. Evaluation of an electronic fish measuring board. ICES J. Mar. Sci., 49:335-339.

Cone, R. S. 1989. The need to reconsider the use of condition indices in fishery science. Trans. Amer. Fish. Soc. 118:510-514.

Courtney, D. L., D. G. Mortensen, J. A. Orsi, and K. M. Munk. 2000. Origin of juvenile Pacific salmon recovered from coastal southeastern Alaska identified by otolith thermal marks and coded wire tags. Fish. Res. 46:267-278.

Eggers, D. 2005. Run forecasts and harvest projections for 2005 Alaska salmon fisheries and review of the 2004 season. Alaska Dept. Fish Game Spec. Publ. 05-01. 83 p.

Eggers, D. 2006. Run forecasts and harvest projections for 2006 Alaska salmon fisheries and review of the 2005 season. Alaska Dept. Fish Game Spec. Publ. 06-07. 83 p.

Hagen, P., and K. Munk. 1994. Stock separation by thermally induced otolith microstructure marks. Pp. 149-156 *In*: Proceedings of the 16th Northeast Pacific Pink and Chum Salmon Workshop. Alaska Sea Grant College Program AK-SG-94-02, University of Alaska, Fairbanks.

Jaenicke, H. W., and A. C. Celewycz. 1994. Marine distribution and size of juvenile Pacific salmon in Southeast Alaska and northern British Columbia. Fish. Bull. 92:79-90.

Jefferts, K. B., P. K. Bergman, and H. F. Fiscus. 1963. A coded wire identification system for macro-organisms. Nature (Lond.) 198:460-462.

Landingham, J. H., M. V. Sturdevant, and R. D. Brodeur. 1998. Feeding habits of juvenile Pacific salmon in marine waters of southeastern Alaska and northern British Columbia. Fish. Bull. 96:285-302.

Minitab. 2000. Minitab user's guide 2: data analysis and quality tools. Minitab statistical software, Release 13.

Mortensen, D. G., A. C. Wertheimer, S. G. Taylor, and J. H. Landingham. 2000. The relationship between early marine growth of pink salmon, *Oncorhynchus gorbuscha*, and marine water temperature, secondary production, and survival to adulthood. Fish. Bull. 98:319-335.

Moss, J. H., D. A. Beauchamp, A. D. Cross, K. W. Myers, E. V. Farley, J. M. Murphy, and J. H. Helle. 2005. Evidence for size-selective mortality after the first summer of ocean growth by pink salmon. Trans. Am. Fish. Soc. 134:1313-1322.

Murphy, J. M., A. L. J. Brase, and J. A. Orsi. 1999. An ocean survey of juvenile salmon in the northern region of southeastern Alaska, May–October. NOAA Tech. Memo. NMFS-AFSC-105. Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 40 p.

Murphy, J. M., and J. A. Orsi. 1999. NOAA Proc. Rep. 99-02. Physical oceanographic observations collected aboard the NOAA Ship *John N. Cobb* in the northern region of southeastern Alaska, 1997 and 1998. 239 p.

Orsi, J. A., J. M. Murphy, and A. L. J. Brase. 1997. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–August 1997. (NPAFC Doc. 277) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 27 p.

Orsi, J. A., J. M. Murphy, and D. G. Mortensen. 1998. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–August 1998. (NPAFC Doc. 346) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 27 p.

Orsi, J. A., D. G. Mortensen, and J. M. Murphy. 1999. Early marine ecology of pink and chum salmon in southeastern Alaska. Pp. 64-72 *In*: Proceedings of the 19th Northeast Pacific Pink and Chum Workshop. Juneau, Alaska.

Orsi, J. A., M. V. Sturdevant, J. M. Murphy, D. G. Mortensen, B. L. Wing, and B. K. Krauss. 2000a. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–October 1999. (NPAFC Doc. 497) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 51 p.

Orsi, J. A., M. V. Sturdevant, J. M. Murphy, D. G. Mortensen, and B. L. Wing. 2000b. Seasonal habitat use and early marine ecology of juvenile Pacific salmon in southeastern Alaska. NPAFC Bull. 2:111-122.

Orsi, J. A., M. V. Sturdevant, A. C. Wertheimer, B. L. Wing, J. M. Murphy, D. G. Mortensen, E. A. Fergusson, and B. K. Krauss. 2001a. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–September 2000. (NPAFC Doc. 536) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 49 p.

Orsi, J. A., M. V. Sturdevant, J. M. Murphy, D. G. Mortensen, B. L. Wing, A. C. Wertheimer, and W. R. Heard. 2001b. Southeast Alaska coastal monitoring for habitat use and early marine ecology of juvenile Pacific salmon. NPAFC Tech. Rep. 2:38-39.

Orsi, J. A., E. A. Fergusson, W. R. Heard, D. G. Mortensen, M. V. Sturdevant, A. C. Wertheimer, and B. L. Wing. 2002. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–September 2001. (NPAFC Doc. 630) Auke Bay Lab., Alaska

Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 51 p.

Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, W. R. Heard, A. C. Wertheimer, and D. G. Mortensen. 2003. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–August 2002. (NPAFC Doc. 702) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 60 p.

Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, W. R. Heard, A. C. Wertheimer, and D. G. Mortensen. 2004a. Survey of juvenile salmon in the marine waters of southeastern Alaska, May–August 2003. (NPAFC Doc. 798) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 59 p.

Orsi, J. A., A. C. Wertheimer, M. V. Sturdevant, E. A. Fergusson, D. G. Mortensen, and B. L. Wing. 2004b. Juvenile chum salmon consumption of zooplankton in marine waters of southeastern Alaska: a bioenergetics approach to implications of hatchery stock interactions. Rev. Fish Biol. Fish. 14:335-359.

Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, A. C. Wertheimer, and W. R. Heard. 2005. Survey of juvenile salmon and associated epipelagic ichthyofauna in the marine waters of southeastern Alaska, May–August 2004. (NPAFC Doc. 871) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 61 p.

Orsi, J. A., D. M. Clausen, A. C. Wertheimer, D. L. Courtney, and J. E. Pohl. 2006. Diel Epipelagic distribution of juvenile salmon, rockfish, sablefish and ecological interactions with associated species in offshore habitats of the northeast Pacific Ocean (NPAFC Doc. 956) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 26 p.

Orsi, J. A., J. A. Harding, S. S. Pool, R. D. Brodeur, L. J. Haldorson, J. M. Murphy, J. H. Moss, E. V. Farley Jr., R. M. Sweeting, J. F. T. Morris, M. Trudel, R. J. Beamish, and R. L. Emmett. In press. Epipelagic fish assemblages associated with juvenile Pacific salmon in neritic waters of the California Current and the Alaska Current. Proceedings of the American Fisheries Society Symposium, Anchorage AK, September 2005.

Park, W., M. Sturdevant, J. Orsi, A. Wertheimer, E. Fergusson, W. Heard, and T. Shirley. 2004. Interannual abundance patterns of copepods during an ENSO event in Icy Strait, southeastern Alaska. ICES J. Mar. Sci. 61(4):464-477.

Parker, R. R. 1968. Marine mortality schedules of pink salmon of the Bella Coola River, central British Columbia. J. Fish. Res. Bd. Can. 25:757-794.

Parr Instrument Co. 1993. Operating Instruction Manual: 1425 Semimicro Bomb Calorimeter No. 280MM. Parr Instrument Co. 21153rd St. Moline, Illinois USA 61265.

Pearcy, W. G. 1997. What have we learned in the last decade? What are research priorities? Pp. 271–277 *In*: R. L. Emmett and M. H. Schiewe (eds.), Estuarine and ocean survival of northeastern Pacific salmon: Proceedings of the workshop. NOAA Tech. Memo. NMFS-NWFSC-29.

Plotnick, M., and D. M. Eggers. 2004. Run forecasts and harvest projections for 2004 Alaska salmon fisheries and review of the 2003 season. Alaska Department Fish Game Regional Inf. Rept. 5J04-01.

Secor, D. H., J. M. Dean, and E. H. Laban. 1992. Otolith removal and preparation for microstructure examination. Can. Spec. Publ. Fish. Aquat. Sci. 117:19-57.

Sturdevant, M. V., E. A. Fergusson, J. A. Orsi, and A. C. Wertheimer. 2002. Diel feeding of juvenile pink, chum, and coho salmon in Icy Strait, southeastern Alaska, May–September 2001 (NPAFC Doc. 631). Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, U. S. Dept. of Commerce, 11305 Glacier Highway, Juneau, AK 99801 8626, USA, 42 p.

Sturdevant, M. V., E. A. Fergusson, J. A. Orsi, and A. C. Wertheimer. 2004. Diel feeding and gastric evacuation of juvenile pink and chum salmon in Icy Strait, southeastern Alaska, May–September 2001. NPAFC Tech. Rep. No. 5: 107-109. Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, DOC, USA. 11305 Glacier Hwy., Juneau, Alaska 99801-8626.

Sturdevant, M. V., E. A. Fergusson, J. A. Orsi, W. Park, B. L. Wing, and A. C. Wertheimer. 2005. Zooplankton dynamics in northern Southeast Alaska. Poster presented at U.S. GLOBEC Ocean Sciences Meeting, Portland, Oregon, January 31-February 2, 2005.

Weitkamp, L., and M. Sturdevant. In press. Influence of juvenile feeding habits on marine survival for Chinook and coho salmon from marine waters of Southeast Alaska. Submitted to Trans. Am. Fish. Soc.

Wertheimer, A. C., W. W. Smoker, T. L. Joyce, and W. R. Heard. 2001. Comment: A review of the hatchery programs for pink salmon in Prince William Sound and Kodiak Island, Alaska. Trans. Amer. Fish. Soc. 130:712-720.

Wertheimer A. C., J. A. Orsi, M. V. Sturdevant, and E. A. Fergusson. 2006. Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated environmental parameters. p. 65-72 *In*: H. Geiger (Rappoteur) (ed.), Proceedings of the 22nd Northeast Pacific Pink and Chum Workshop. Pacific Salmon Commission, Vancouver, British Columbia.

White, B. W. 2006. Alaska salmon enhancement program 2005 annual report. Alaska Department of Fish and Game, Fishery Management Report No. 06-19, Anchorage.

Willette, T.M., R. T. Cooney, V. Patrick, D. M. Mason, G. L. Thomas, and D. Scheel. 2001. Ecological processes influencing mortality of juvenile pink salmon (*Oncorhynchus gorbuscha*) in Prince William Sound, Alaska. Fish. Oceanogr.10:14-41.

Table 1.—Localities and coordinates of stations sampled in different habitats of the marine waters of the northern and southern regions of southeastern Alaska using the NOAA ship *John N. Cobb*, May–August 2005. Station positions are shown in Figure 1.

				Distance		
Habitat	Station	Latitude north	Longitude west	offshore (km)	between (km)	Bottom depth (m)
			Northern region			
			Auke Bay Monitor			
Inshore	ABM	58°22.00'	134°40.00'	1.5	—	60
			Upper Chatham Strait transect			
Strait	UCA	58°04.57'	135°00.08'	3.2	—	400
	UCB	58°06.22'	135°00.91'	6.4	3.2	100
	UCC	58°07.95'	135°01.69'	6.4	3.2	100
	UCD	58°09.64'	135°02.52'	3.2	3.2	200
			Icy Strait transect			
Strait	ISA	58°13.25'	135°31.76'	3.2	—	128
	ISB	58°14.22'	135°29.26'	6.4	3.2	200
	ISC	58°15.28'	135°26.65'	6.4	3.2	200
	ISD	58°16.38'	135°23.98'	3.2	3.2	234
			Icy Point transect			
Coastal	IPA	58°20.12'	137°07.16'	6.9	—	160
	IPB	58°12.71'	137°16.96'	23.4	16.8	130
	IPC	58°05.28'	137°26.75'	40.2	16.8	150
	IPD	57°53.50'	137°42.60'	65.0	24.8	1,300
			Southern region			
			Middle Clarence Strait transect			
Strait	MCA	55°23.05'	131°55.49'	3.2	—	346
	MCB	55°24.26'	131°58.23'	6.4	3.2	439
	MCC	55°25.06'	132°01.19'	6.4	3.2	412
	MCD	55°25.79'	132°03.93'	3.2	3.2	461

Table 1.—cont.

Habitat	Station	Latitude North	Longitude west	Distance offshore (km)	Distance between (km)	Bottom depth (m)
		Lower Clarence Strait transect				
Strait	LCA	55°07.53'	131°48.09'	3.2	—	413
	LCB	55°07.32'	131°51.09'	6.4	3.2	459
	LCC	55°07.14'	131°56.79'	6.4	3.2	466
	LCD	55°06.93'	131°56.79'	3.2	3.2	315

Table 2.—Numbers and types of data collected in different habitats sampled monthly in marine waters of the northern and southern regions of southeastern Alaska, May–August 2005.

		Data collection type[1]					
Dates (days)	Habitat	Rope trawl	CTD cast	Oblique bongo	20-m vertical	WP-2 vertical	Chlorophyll & nutrients
		Northern region					
22-25 May (4 days)	Inshore	0	1	2	3	1	2
	Strait	0	8	8	8	0	16
	Coastal	0	4	8	4	4	8
27 June-02 July (6 days)	Inshore	0	1	2	3	1	2
	Strait	20	20	8	20	0	16
	Coastal	0	0	0	0	0	0
26-31 July (13 days)	Inshore	0	1	2	3	1	2
	Strait	23	23	8	22	0	16
	Coastal	0	0	0	0	0	0
23-29 August (7 days)	Inshore	0	1	2	3	1	1
	Strait	8	8	8	8	0	8
	Coastal	0	0	0	0	0	0
		Southern region					
21-25 June (5 days)	Strait	20	20	8	20	0	16
21-25 July (5 days)	Strait	21	25	8	21	0	16
Total		92	112	64	115	8	103

[1]Rope trawl = 20-min hauls with NORDIC 264 surface trawl 18 m deep by 24 m wide; CTD casts = to 200 m or within 10 m of the bottom; oblique bongo = 60-cm diameter frame, 505- and 333-µm meshes, towed double obliquely down to and up from a depth of 200 m or within 20 m of the bottom; 20-m vertical = 50-cm diameter frame, 243-µm conical NORPAC net towed vertically from 20 m depth; WP-2 vertical = 57-cm diameter frame, 202-µm conical net towed vertically from 200 m or within 10 m of the bottom; chlorophyll and nutrients are from surface and 20-m seawater samples.

Table 3.—Surface (3-m) temperature (°C) and salinity (PSU) data collected monthly in different habitats of the marine waters of the northern and southern regions of southeastern Alaska, May–August 2005. Station code acronyms are listed in Table 1.

Month	Temp	Salinity	Temp	Salinity	Temp	Salinity	Temp	Salinity
Northern region								
Auke Bay Monitor								
	ABM							
May	12.3	21.6						
June	13.9	20.9						
July	13.3	16.5						
August	14.5	16.5						
Upper Chatham Strait transect								
	UCA		UCB		UCC		UCD	
May	10.7	28.9	10.0	29.9	10.4	29.0	9.9	28.9
June	13.7	25.7	14.3	21.1	14.3	19.0	14.6	18.0
July	12.3	16.1	13.0	15.8	13.3	13.8	13.3	14.0
August	10.3	23.8	11.1	22.9	12.6	22.2	13.0	23.7
Icy Strait transect								
	ISA		ISB		ISC		ISD	
May	11.0	28.5	11.5	28.6	10.7	28.9	9.3	29.9
June	14.0	23.6	14.0	22.1	14.1	21.3	14.2	21.2
July	12.5	15.3	13.1	14.6	13.3	16.3	13.3	16.8
August	9.6	22.8	9.9	22.0	12.3	23.7	12.5	24.4
Icy Point transect								
	IPA		IPB		IPC		IPD	
May	9.3	31.1	10.7	31.5	10.7	31.4	11.0	31.4
June	—	—	—	—	—	—	—	—
July	—	—	—	—	—	—	—	—
August	—	—	—	—	—	—	—	—
Southern region								
Middle Clarence Strait transect								
	MCA		MCB		MCC		MCD	
May	—	—	—	—	—	—	—	—
June	14.4	27.0	14.5	27.2	14.5	27.2	14.1	27.1
July	15.6	24.7	15.7	23.6	15.3	24.1	15.4	24.5
August	—	—	—	—	—	—	—	—

Table 3.—cont.

Month	Temp (^oC)	Salinity (PSU)	Temp (^oC)	Salinity (PSU)	Temp (^oC)	Salinity (PSU)	Temp (^oC)	Salinity (PSU)
	Lower Clarence Strait transect							
	LCA		LCB		LCC		LCD	
May	—	—	—	—	—	—	—	—
June	13.7	28.6	14.0	28.1	14.4	27.8	13.8	28.2
July	14.9	26.7	15.1	26.4	15.0	26.5	15.2	26.4
August	—	—	—	—	—	—	—	—

Table 4.—Nutrient and chlorophyll concentrations from 200-ml surface water samples in marine waters of the northern and southern regions of southeastern Alaska, May–August 2005. Station code acronyms are listed in Table 1.

		Nutrients [µM]						
Station	Month	[PO_4]	[$Si(OH)_4$]	[NO_3]	[NO_2]	[NH_4]	Chlorophyll ($mg \cdot m^{-3}$)	Phaeopigment ($mg \cdot m^{-3}$)
				Northern region				
				Surface samples				
				Auke Bay Monitor				
ABM	May	0.05	8.79	0.00	0.02	0.69	1.01	0.40
	June	0.03	0.00	0.08	0.11	0.76	0.53	0.21
	July	0.00	0.26	0.00	0.00	0.77	0.62	0.09
	August	0.03	1.62	0.00	0.00	0.74	0.90	0.28
				Icy Point transect				
IPA	May	1.09	8.62	10.57	0.15	1.66	1.05	0.40
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPB	May	0.68	3.29	0.66	0.00	0.97	0.57	0.28
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPC	May	0.45	2.37	0.05	0.00	0.55	0.47	0.29
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPD	May	0.58	4.33	1.21	0.03	1.16	0.71	0.28
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
				Upper Chatham Strait transect				
UCA	May	0.24	5.45	0.17	0.00	1.17	1.11	0.26
	June	0.34	3.77	0.56	0.03	0.76	3.17	0.16
	July	0.17	4.43	0.50	0.01	0.30	4.11	0.10
	August	1.08	18.75	11.95	0.26	0.66	0.96	0.52
UCB	May	0.29	5.55	0.11	0.00	1.44	2.17	0.50
	June	0.20	5.48	0.57	0.02	0.80	3.28	0.29
	July	0.12	4.39	0.11	0.00	0.32	1.16	0.16
	August	0.76	13.05	7.54	0.18	0.78	1.47	0.54

Table 4.—(Cont.)

Station	Month	Nutrients [µM] $[PO_4]$	$[Si(OH)_4]$	$[NO_3]$	$[NO_2]$	$[NH_4]$	Chlorophyll ($mg \cdot m^{-3}$)	Phaeopigment ($mg \cdot m^{-3}$)
UCC	May	0.55	6.16	2.15	0.03	1.50	—	—
	June	0.03	1.14	0.33	0.00	0.30	2.01	0.59
	July	0.07	3.20	0.00	0.00	0.35	0.59	0.17
	August	0.42	6.84	2.84	0.12	1.71	2.63	0.50
UCD	May	0.44	2.84	0.43	0.00	1.73	1.58	0.37
	June	0.03	1.82	0.33	0.00	0.41	1.48	0.34
	July	0.00	2.91	0.00	0.00	0.36	0.56	0.14
	August	0.19	2.85	0.35	0.03	1.00	4.81	0.36
				Icy Strait transect				
ISA	May	0.26	5.07	0.37	0.01	0.32	2.66	0.38
	June	0.38	6.65	1.22	0.07	1.63	1.62	0.18
	July	0.35	15.23	5.10	0.11	0.29	3.83	0.09
	August	1.39	31.33	18.31	0.19	0.80	2.32	0.73
ISB	May	0.25	4.05	0.23	0.01	0.53	1.35	0.25
	June	0.03	2.73	0.19	0.06	1.02	0.73	0.20
	July	0.08	5.91	0.18	0.04	0.49	1.23	0.29
	August	1.31	24.95	15.08	0.20	1.20	2.11	0.46
ISC	May	0.20	4.06	0.05	0.00	0.49	1.46	0.13
	June	0.13	6.82	0.50	0.02	1.42	1.87	0.22
	July	0.02	6.01	0.12	0.05	1.08	2.66	0.24
	August	0.65	9.55	5.76	0.13	0.86	2.66	0.21
ISD	May	0.28	5.88	0.80	0.01	0.29	1.32	0.23
	June	0.08	5.72	0.30	0.00	2.01	1.84	0.20
	July	0.06	5.16	0.00	0.01	0.31	2.54	0.48
	August	0.55	6.23	3.76	0.13	1.20	2.68	0.48
				20-m samples Auke Bay Monitor				
ABM	May	1.15	20.80	12.51	0.17	3.20	0.42	0.72
	June	1.07	20.43	10.20	0.16	2.74	0.34	0.41
	July	0.88	10.47	6.24	0.12	2.79	0.56	1.10
	August	—	—	—	—	—	—	—

Table 4.—(Cont.)

Station	Month	Nutrients [µM] [PO_4]	[$Si(OH)_4$]	[NO_3]	[NO_2]	[NH_4]	Chlorophyll ($mg \cdot m^{-3}$)	Phaeopigment ($mg \cdot m^{-3}$)
				Icy Point transect				
IPA	May	1.06	14.40	9.55	0.09	0.00	0.58	0.36
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPB	May	0.72	4.37	2.01	0.04	1.67	0.89	0.69
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPC	May	1.06	7.50	6.71	0.11	1.12	1.06	0.42
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
IPD	May	0.91	7.26	6.04	0.09	1.70	0.96	0.59
	June	—	—	—	—	—	—	—
	July	—	—	—	—	—	—	—
	August	—	—	—	—	—	—	—
				Upper Chatham Strait transect				
UCA	May	0.65	10.19	6.53	0.07	1.26	2.52	0.39
	June	1.14	32.46	15.74	0.30	1.86		
	July	0.93	30.72	19.30	0.29	1.39	0.22	0.23
	August	—	—	—	—	—	—	—
UCB	May	0.85	11.22	7.28	0.09	1.87	1.85	0.43
	June	1.22	33.74	16.82	0.31	2.11	0.39	0.06
	July	1.55	30.11	18.30	0.26	1.21	0.18	0.39
	August	—	—	—	—	—	—	—
UCC	May	1.88	34.01	18.06	0.17	4.08	0.51	0.86
	June	1.05	30.85	14.17	0.24	1.24	0.72	0.07
	July	1.04	27.00	16.53	0.26	1.57	0.31	0.41
	August	—	—	—	—	—	—	—
UCD	May	1.68	27.37	15.62	0.17	4.43	1.73	1.18
	June	0.53	12.13	4.65	0.18	0.47	1.07	0.43
	July	0.81	11.65	8.97	0.17	2.63	0.66	0.47
	August	—	—	—	—	—	—	—

Table 4.—(Cont.)

Station	Month	Nutrients [µM] [PO_4]	[$Si(OH)_4$]	[NO_3]	[NO_2]	[NH_4]	Chlorophyll (mg · m^{-3})	Phaeopigment (mg · m^{-3})
				Icy Strait transect				
ISA	May	1.54	28.60	14.91	0.16	4.26	1.81	0.53
	June	1.63	35.93	18.77	0.24	1.55	0.64	0.24
	July	1.22	33.46	15.50	0.17	0.82	1.94	0.82
	August	—	—	—	—	—	—	—
ISB	May	1.50	30.74	15.33	0.15	2.67	0.76	0.50
	June	1.28	31.76	16.55	0.23	1.52	0.40	0.33
	July	1.52	40.29	19.24	0.20	1.08	1.72	0.98
	August	—	—	—	—	—	—	—
ISC	May	1.51	26.61	14.08	0.14	4.39	0.78	1.12
	June	1.43	31.08	15.49	0.25	1.64	0.12	0.98
	July	0.97	33.00	14.45	0.19	1.61	1.48	0.79
	August	—	—	—	—	—	—	—
ISD	May	1.45	31.14	15.89	0.14	2.10	0.55	0.63
	June	1.32	32.53	16.65	0.27	2.01	0.30	0.30
	July	1.09	31.00	16.28	0.21	1.28	0.94	0.66
	August	—	—	—	—	—	—	—
				Southern region				
				Surface samples Middle Clarence Strait transect				
MCA	May	—	—	—	—	—	—	—
	June	0.09	2.03	0.00	0.04	0.39	0.32	0.07
	July	0.16	7.45	0.07	0.01	0.16	2.04	0.45
	August	—	—	—	—	—	—	—
MCB	May	—	—	—	—	—	—	—
	June	0.00	1.41	0.00	0.01	0.31	0.27	0.08
	July	0.15	7.50	0.00	0.00	0.98	1.19	0.37
	August	—	—	—	—	—	—	—
MCC	May	—	—	—	—	—	—	—
	June	0.03	2.21	0.16	0.01	0.32	0.25	0.06
	July	0.13	11.87	0.12	0.00	0.76	0.60	0.13
	August	—	—	—	—	—	—	—

Table 4.—(Cont.)

Station	Month	Nutrients [µM] [PO_4]	[$Si(OH)_4$]	[NO_3]	[NO_2]	[NH_4]	Chlorophyll (mg · m^{-3})	Phaeopigment (mg · m^{-3})
MCD	May	—	—	—	—	—	—	—
	June	0.02	1.84	0.01	0.03	0.46	0.30	0.08
	July	0.17	10.08	0.12	0.02	0.25	1.31	0.16
	August	—	—	—	—	—	—	—
				Lower Clarence Strait transect				
LCA	May	—	—	—	—	—	—	—
	June	0.26	1.67	0.92	0.02	0.13	1.66	0.65
	July	0.27	9.02	0.00	0.02	0.47	1.81	0.53
	August	—	—	—	—	—	—	—
LCB	May	—	—	—	—	—	—	—
	June	0.14	1.56	0.99	0.01	0.13	0.65	0.15
	July	0.59	9.98	0.05	0.01	1.68	1.85	0.34
	August	—	—	—	—	—	—	—
LCC	May	—	—	—	—	—	—	—
	June	0.13	1.69	0.99	0.00	0.23	0.41	0.17
	July	0.20	8.87	0.00	0.03	0.42	1.65	0.40
	August	—	—	—	—	—	—	—
LCD	May	—	—	—	—	—	—	—
	June	0.16	1.74	1.34	0.02	0.24	0.82	0.15
	July	0.14	5.01	0.00	0.00	0.42	1.08	0.30
	August	—	—	—	—	—	—	—
				20-m samples Middle Clarence Strait transect				
MCA	May	—	—	—	—	—	—	—
	June	0.46	5.43	3.45	0.09	0.94	1.61	0.91
	July	0.81	21.74	9.03	0.34	0.85	0.25	0.29
	August	—	—	—	—	—	—	—
MCB	May	—	—	—	—	—	—	—
	June	0.41	3.90	2.83	0.08	0.65	3.24	1.17
	July	0.49	16.05	3.71	0.21	1.20	0.55	0.42
	August	—	—	—	—	—	—	—

Table 4.—(Cont.)

Station	Month	Nutrients [µM] $[PO_4]$	$[Si(OH)_4]$	$[NO_3]$	$[NO_2]$	$[NH_4]$	Chlorophyll ($mg \cdot m^{-3}$)	Phaeopigment ($mg \cdot m^{-3}$)
MCC	May	—	—	—	—	—	—	—
	June	0.53	5.70	4.46	0.11	0.86	2.46	0.76
	July	0.79	23.17	6.49	0.40	1.21	0.47	0.34
	August	—	—	—	—	—	—	—
MCD	May	—	—	—	—	—	—	—
	June	0.78	8.49	6.36	0.14	1.08	1.81	0.88
	July	0.87	18.98	8.09	0.38	0.94	0.52	0.43
	August	—	—	—	—	—	—	—
				Lower Clarence Strait transect				
LCA	May	—	—	—	—	—	—	—
	June	0.48	3.08	7.17	0.13	0.50	3.47	1.33
	July	0.80	12.84	6.28	0.35	1.52	0.52	0.30
	August	—	—	—	—	—	—	—
LCB	May	—	—	—	—	—	—	—
	June	0.64	7.88	5.99	0.13	0.77	0.52	0.16
	July	0.97	14.05	7.50	0.38	1.56	0.36	0.23
	August	—	—	—	—	—	—	—
LCC	May	—	—	—	—	—	—	—
	June	0.73	7.68	6.64	0.16	0.97	1.96	1.08
	July	0.47	6.54	2.47	0.12	0.69	0.61	0.33
	August	—	—	—	—	—	—	—
LCD	May	—	—	—	—	—	—	—
	June	0.68	8.64	7.52	0.19	0.82	1.82	0.86
	July	0.58	10.99	3.74	0.24	0.76	1.01	0.48
	August	—	—	—	—	—	—	—

Table 5.— Mean zooplankton settled volumes (ZSV, ml) and total plankton settled volumes (TSV, ml) of vertical 20-m NORPAC hauls from the marine waters of the northern and southern regions of southeastern Alaska, May–August 2005. Discreet phytoplankton layers were not visible in any samples. Volume differences between ZSV and TSV are caused by presence of slub in sample. Standing stock (ml · m^{-3}) can be computed by dividing by the water volume filtered, a factor of 3.9 m^3. Station code acronyms are listed in Table 1.

Month	*n*	ZSV	TSV	*n*	ZSV	TSV	*n*	ZSV	TSV	*n*	ZSV	TSV
Northern region												
Auke Bay Monitor												
	ABM											
May	3	8.8	8.7									
June	3	14.2	18.2									
July	3	11.8	26.0									
August	3	28.0	36.0									
Upper Chatham Strait transect												
	UCA			UCB			UCC			UCD		
May	1	17.0	17.0	1	18.0	18.0	1	13.0	13.0	1	20.0	20.0
June	2	8.3	15.5	2	20.5	26.0	2	8.3	14.3	2	13.5	15.0
July	2	8.0	11.5	2	7.8	9.5	2	8.3	10.0	3	8.3	10.7
August	1	3.0	3.0	1	2.0	2.5	1	5.5	6.0	1	5.0	6.0
Icy Strait transect												
	ISA			ISB			ISC			ISD		
May	1	11.5	11.5	1	27.0	27.0	1	20.0	20.0	1	18.0	18.0
June	3	12.0	20.0	3	12.5	22.3	3	9.3	13.0	3	12.5	18.8
July	3	28.3	65.0	3	17.8	32.3	3	17.7	30.3	4	22.9	43.3
August	1	10.0	12.0	1	23.0	34.0	1	4.0	5.0	1	12.0	14.0
Icy Point transect												
	IPA			IPB			IPC			IPD		
May	1	6.5	6.5	1	4.0	4.0	1	5.0	5.0	1	4.0	4.0
June	—	—	—	—	—	—	—	—	—	—	—	—
July	—	—	—	—	—	—	—	—	—	—	—	—
August	—	—	—	—	—	—	—	—	—	—	—	—
Southern region												
Middle Clarence Strait transect												
	MCA			MCB			MCC			MCD		
May	—	—	—	—	—	—	—	—	—	—	—	—
June	2	12.5	14.0	2	7.5	11.5	2	11.0	13.0	2	9.5	13.3
July	2	4.3	5.8	2	5.5	7.5	2	2.7	3.3	2	4.0	5.5
August	—	—	—	—	—	—	—	—	—	—	—	—

Table 5. —(Cont.)

Month	*n*	ZSV	TSV	*n*	ZSV	TSV	*n*	ZSV	TSV	*n*	ZSV	TSV
	Lower Clarence Strait transect											
	LCA			LCB			LCC			LCD		
May	—	—	—	—	—	—	—	—	—	—	—	—
June	3	16.8	23.3	3	9.2	10.7	3	8.0	9.8	3	9.0	12.8
July	3	9.1	9.8	3	3.5	6.0	4	4.1	5.1	3	3.5	5.0
August	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.—Zooplankton displacement volumes (DV, ml), standing stock (ml · m^{-3}), and total density (number · m^{-3}) of daytime, deep ($\leq$ 200-m) double oblique bongo (333-and 505-µm mesh) hauls from the marine waters of the northern and southern regions of southeastern Alaska, May–August 2005. Standing stock (ml · m^{-3}) is computed using flowmeter readings to determine water volume filtered.

Month	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density
Northern region																
Icy Strait transect																
333-µm mesh																
	ISA				ISB				ISC				ISD			
May	217	160	0.6	1283.5	175	180	0.7	1343.6	209	200	0.7	1295.8	73	175	1.6	850.8
June	90	50	0.4	903.0	176	100	0.5	915.2	200	405	1.4	1258.0	194	175	0.9	677.7
July	90	80	0.7	1490.8	174	90	0.4	748.9	202	55	0.2	111.2	214	115	0.5	914.8
August	104	60	0.4	844.5	161	85	0.4	713.6	207	125	0.5	864.8	220	40	0.2	191.5
505-µm mesh																
	ISA				ISB				ISC				ISD			
May	217	115	0.5	—	175	125	0.5	—	209	70	0.3	—	73	65	0.6	—
June	90	25	0.2	—	176	45	0.2	—	200	350	1.2	—	194	160	0.8	—
July	90	40	0.4	—	174	45	0.2	—	202	105	0.4	—	214	80	0.3	—
August	104	25	0.2	—	161	45	0.2	—	207	80	0.3	—	220	30	0.3	—
Southern region																
Lower Clarence Strait transect																
333-µm mesh																
	LCA				LCB				LCC				LCD			
May	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
June	215	45	0.2	424.6	215	55	0.2	381.4	222	50	0.2	403.6	204	90	0.3	255.7
July	183	45	0.2	209.1	226	40	0.2	289.5	201	35	0.1	189.2	201	45	0.2	242.2
August	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.—(Cont.)

Month	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density	Depth (m)	DV	Standing stock	Total density
	505-µm mesh															
	LCA				LCB				LCC				LCD			
May	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
June	215	45	0.2	—	215	35	0.1	—	222	10	0.0	—	204	40	0.2	—
July	183	55	0.2	—	226	35	0.1	—	201	20	0.1	—	201	85	0.3	—
August	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 7.—Numbers of fish and squid captured in 51 rope trawl hauls in the marine waters of the northern region of southeastern Alaska, June–August 2005.

Common name	Scientific name	Number caught			
		June	July	August	Total
Salmonids					
Chum salmon[1]	*Oncorhynchus keta*	1,650	113	97	1,860
Pink salmon[1]	*O. gorbuscha*	495	119	497	1,111
Coho salmon[1]	*O. kisutch*	264	106	44	414
Sockeye salmon[1]	*O. nerka*	154	25	15	194
Pink salmon[3]	*O. gorbuscha*	5	15	3	23
Chinook salmon[1]	*O. tshawytscha*	9	6	1	16
Chinook salmon[2]	*O. tshawytscha*	1	3	0	4
Chinook salmon[3]	*O. tshawytscha*	3	0	1	4
Chum salmon[3]	*O. keta*	0	2	1	3
Sockeye salmon[2]	*O. nerka*	1	0	0	1
Coho salmon[3]	*O. kisutch*	0	1	0	1
Sockeye salmon[3]	*O. nerka*	0	1	0	1
Total salmonids					3,632
Non-salmonids					
Crested sculpin	*Blepsias bilobus*	11	56	8	75
Prowfish	*Zaprora silenus*	2	8	1	11
Wolf-eel	*Anarrhichthys ocellatus*	2	4	1	7
Walleye pollock larvae	*Theragra chalcogramma*	1	4	0	5
Pacific herring	*Clupea pallasi*	2	0	0	2
Spiny lumpsucker	*Eumicrotremus orbis*	0	1	1	2
Walleye pollock	*Theragra chalcogramma*	0	2	0	2
Smooth lumpsucker	*Aptocyclus ventricosus*	1	0	0	1
Salmon shark	*Lamna ditropis*	0	1	0	1
Unknown larvae	Teleostei	1	0	0	1
Total non-salmonids					107
Grand total fish and squid					3,739

[1]Juvenile [2]Immature [3]Adult

Table 8.— Numbers of fish and squid captured in 41 rope trawl hauls in the marine waters of the southern region of southeastern Alaska, June–July 2005.

Common name	Scientific name	Number caught June	July	Total
		Salmonids		
Pink salmon[1]	*Oncorhynchus gorbuscha*	1,665	86	1,751
Chum salmon[1]	*O. keta*	681	153	834
Sockeye salmon[1]	*O. nerka*	160	19	179
Coho salmon[1]	*O. kisutch*	183	49	232
Chinook salmon[1]	*O. tshawytscha*	7	2	9
Pink salmon[3]	*O. gorbuscha*	0	8	8
Coho salmon[3]	*O. kisutch*	1	0	1
Chinook salmon[2]	*O. tshawytscha*	3	0	3
Chum salmon[3]	*O. keta*	0	1	1
Chinook salmon[3]	*O. tshawytscha*	0	1	1
Total salmonids				3,019
		Non-salmonids		
Market squid (black)	*Loligo* spp.	63	0	63
Walleye pollock larvae	*Theragra chalcogramma*	11	13	24
Prowfish	*Zaprora silenus*	4	8	12
Spiny dogfish	*Squalus acanthias*	1	8	9
Pacific herring	*Clupea pallasi*	2	0	2
Starry flounder	*Platichthys stellatus*	2	0	2
Squid	Gonatidae	2	0	2
Poacher	Agonidae	1	0	1
Pacific cod larvae	*Gadus macrocephalus*	1	0	1
Total non-salmonids				116
Grand total fish and squid				3,135

[1]Juvenile [2]Immature [3]Adult

Table 9.—Frequency of occurrence of fishes and squid captured in marine waters of the northern region of southeastern Alaska in 51 rope trawl hauls, June–August 2005. The overall percent frequency of occurrence of fish is also shown.

Common name	Scientific name	Frequency of occurrence June	July	August	Total	(%)
		Salmonids				
Chum salmon[1]	*Oncorhynchus keta*	20	14	7	41	80
Pink salmon[1]	*O. gorbuscha*	16	16	8	40	78
Coho salmon[1]	*O. kisutch*	19	17	8	44	86
Sockeye salmon[1]	*O. nerka*	16	12	4	32	63
Pink salmon[3]	*O. gorbuscha*	4	6	1	11	22
Chinook salmon[1]	*O. tshawytscha*	7	5	1	13	25
Chinook salmon[2]	*O. tshawytscha*	1	3	0	4	8
Chinook salmon[3]	*O. tshawytscha*	2	0	1	3	6
Chum salmon[3]	*O. keta*	0	2	1	3	6
Sockeye salmon[2]	*O. nerka*	1	0	0	1	2
Coho salmon[3]	*O. kisutch*	0	1	0	1	2
Sockeye salmon[3]	*O. nerka*	0	1	0	1	2
		Non-salmonids				
Crested sculpin	*Blepsias bilobus*	9	18	6	33	65
Prowfish	*Zaprora silenus*	2	6	1	9	18
Wolf-eel	*Anarrhichthys ocellatus*	2	3	1	6	12
Walleye pollock larvae	*Theragra chalcogramma*	1	4	0	5	10
Pacific herring	*Clupea pallasi*	2	0	0	2	4
Spiny lumpsucker	*Eumicrotremus orbis*	0	1	1	2	4
Walleye pollock	*Theragra chalcogramma*	0	2	0	2	4
Smooth lumpsucker	*Aptocyclus ventricosus*	1	0	0	1	2
Salmon shark	*Lamna ditropis*	0	1	0	1	2
Unknown larvae	Teleostei	1	0	0	1	2

[1]Juvenile [2]Immature [3]Adult

Table 10.—Frequency of occurrence of fishes and squid captured in marine waters of the southern region of southeastern Alaska in 41 rope trawl hauls, June–August 2005. The overall percent frequency of occurrence of fish is also shown.

Common name	Scientific name	Frequency of occurrence			
		June	July	Total	(%)
	Salmonids				
Pink salmon[1]	*Oncorhynchus gorbuscha*	17	10	27	66
Chum salmon[1]	*O. keta*	19	15	34	83
Sockeye salmon[1]	*O. nerka*	17	9	26	63
Coho salmon[1]	*O. kisutch*	19	11	30	73
Chinook salmon[1]	*O. tshawytscha*	6	2	8	20
Pink salmon[3]	*O. gorbuscha*	0	5	5	12
Coho salmon[3]	*O. kisutch*	1	0	1	2
Chinook salmon[2]	*O. tshawytscha*	3	0	3	7
Chum salmon[3]	*O. keta*	0	1	1	2
Chinook salmon[3]	*O. tshawytscha*	0	1	1	2
	Non-salmonids				
Market squid (black)	*Loligo* spp.	1	0	1	2
Walleye pollock larvae	*Theragra chalcogramma*	4	6	10	24
Prowfish	*Zaprora silenus*	4	6	10	24
Spiny dogfish	*Squalus acanthias*	1	4	5	12
Pacific herring	*Clupea pallasi*	2	0	2	5
Starry flounder	*Platichthys stellatus*	2	0	2	5
Squid	Gonatidae	2	0	2	5
Poacher	Agonidae	1	0	1	2
Pacific cod larvae	*Gadus macrocephalus*	1	0	1	2

[1]Juvenile [2]Immature [3]Adult

Table 11.—Length (FL, mm), weight (g), and condition [(g · mm^{-3}) · (10^5)] of juvenile pink salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. A subset of samples, not reported in the following data tables, was preserved for diet analysis.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern region													
Upper Chatham Strait	Length	69	85-131	104.7	1.1	58	104-182	124.9	1.7	276	123-215	172.6	1.0
	Weight	61	5.2-22.5	10.5	0.4	33	9.2-61.1	18.7	1.5	274	16.5-108.0	54.2	1.0
	Condition	61	0.8-1.1	0.9	0.0	33	0.7-1.1	0.9	0.0	141	0.7-1.3	1.0	0.0
Icy Strait	Length	282	85-143	108.6	0.6	59	104-196	133.8	2.2	221	126-211	167.8	1.0
	Weight	281	5.3-28.7	12.3	0.2	47	10.8-73.6	23.2	1.7	215	20.1-90.9	47.2	0.9
	Condition	281	0.7-1.2	0.9	0.0	47	0.8-1.0	0.9	0.0	173	0.8-1.2	1.0	0.0
Southern region													
Middle Clarence Strait	Length	1,054	55-125	89.1	0.3	13	105-133	118.6	2.7	—	—	—	—
	Weight	398	2.8-16.9	6.7	0.1	5	10.6-20.7	16.2	2.1	—	—	—	—
	Condition	398	0.5-1.8	0.9	0.0	5	0.9-1.0	1.0	0.0	—	—	—	—
Lower Clarence Strait	Length	481	65-221	88.2	0.6	58	101-152	125.0	1.3	—	—	—	—
	Weight	295	2.5-25.2	6.0	0.1	58	8.5-33.0	17.5	0.5	—	—	—	—
	Condition	295	0.3-2.6	0.8	0.0	58	0.6-1.1	0.9	0.0	—	—	—	—
Grand total													
	Length	1,886	55-221	92.3	0.3	188	101-196	127.3	1.0	497	123-215	170.4	0.7
	Weight	1,035	2.5-28.7	8.3	0.1	143	8.5-73.6	19.6	0.7	489	16.5-108.0	51.1	0.7
	Condition	1,035	0.3-2.6	0.9	0.0	143	0.6-1.1	0.9	0.0	314	0.7-1.3	1.0	0.0

Table 12.—Length (FL, mm), weight (g), and condition $[(g \cdot mm^{-3}) \cdot (10^5)]$ of juvenile chum salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. A subset of samples, not reported in the following data tables, was preserved for diet analysis.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern region													
Upper Chatham Strait	Length	148	79-137	109.1	0.8	55	95-163	126.5	2.2	40	149-219	192.3	2.8
	Weight	113	5.3-25.9	12.9	0.4	54	6.9-38.0	18.3	1.0	40	32.8-120.8	80.8	8.5
	Condition	113	0.7-1.2	0.9	0.0	54	0.7-1.0	0.9	0.1	40	0.9-1.3	1.1	0.1
Icy Strait	Length	684	85-211	115.0	0.4	57	99-173	125.9	2.2	56	142-225	189.5	2.7
	Weight	237	6.8-31.3	15.5	0.3	57	9.5-51.2	19.6	1.2	56	23.2-132.2	77.2	10.8
	Condition	237	0.8-1.2	1.0	0.0	57	0.8-1.1	0.9	0.0	56	0.3-1.3	1.1	0.1
Southern region													
Middle Clarence Strait	Length	232	65-133	93.6	1.0	43	91-168	121.6	2.0	—	—	—	—
	Weight	215	2.7-22.8	8.4	0.3	29	7.1-44.4	17.8	1.4	—	—	—	—
	Condition	215	0.4-1.9	1.0	0.0	29	0.8-1.1	0.9	0.1	—	—	—	—
Lower Clarence Strait	Length	106	65-170	96.3	1.3	65	103-189	122.9	1.6	—	—	—	—
	Weight	105	2.9-48.2	8.5	0.5	65	10.9-66.0	18.3	1.0	—	—	—	—
	Condition	105	0.4-2.7	0.9	0.0	65	0.8-1.1	1.0	0.1	—	—	—	—
Grand total													
	Length	1,170	65-211	108.3	0.4	220	91-189	124.3	1.0	96	142-225	190.6	2.0
	Weight	670	2.7-48.2	11.7	0.2	205	6.9-66.0	18.6	8.1	96	23.2-132.1	78.7	19.2
	Condition	670	0.4-2.7	1.0	0.0	205	0.7-1.1	0.9	0.1	96	0.3-1.3	1.1	0.1

Table 13.—Length (FL, mm), weight (g), and condition [(g · mm^{-3}) · (10^5)] of juvenile sockeye salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						Northern region							
Upper Chatham Strait	Length	75	85-155	118.9	2.0	15	76-156	107.8	5.8	10	169-197	181.6	2.6
	Weight	75	5.4-36.1	17.6	0.9	15	3.6-40.1	13.2	2.6	10	49.9-87.2	65.4	3.7
	Condition	75	0.7-1.2	1.0	0.0	15	0.8-1.1	0.9	0.0	10	0.9-1.2	1.1	8.2
Icy Strait	Length	100	82-173	117.9	1.6	10	93-165	118.9	8.5	5	172-182	178.0	2.0
	Weight	99	5.4-55.8	17.5	0.8	10	7.5-45.1	19.1	4.6	5	49.8-63.4	57.2	2.3
	Condition	99	0.8-1.2	1.0	0.0	10	0.9-1.0	1.0	0.0	5	0.9-1.1	1.0	8.6
						Southern region							
Middle Clarence Strait	Length	74	67-163	107.8	2.4	9	119-152	132.9	3.9	—	—	—	—
	Weight	73	3.7-42.3	13.7	1.0	9	15.8-33.5	23.7	2.2	—	—	—	—
	Condition	73	0.5-1.4	1.0	0.0	9	0.9-1.2	1.0	0.0	—	—	—	—
Lower Clarence Strait	Length	81	77-150	113.3	1.7	10	125-161	139.1	3.2	—	—	—	—
	Weight	81	3.4-33.6	13.9	0.7	10	18-47.7	28.2	2.6	—	—	—	—
	Condition	81	0.5-2.7	0.9	0.0	10	0.9-1.1	1.0	0.0	—	—	—	—
						Grand total							
	Length	330	67-173	114.7	1.0	44	76-165	122.6	3.5	15	169-197	180.4	1.9
	Weight	328	3.4-55.8	15.8	0.4	44	3.6-47.7	20.1	1.7	15	49.8-87.2	62.7	2.8
	Condition	328	0.5-2.7	1.0	0.0	44	0.8-1.2	1.0	0.0	15	0.9-1.2	1.1	9.8

Table 14.—Length (FL, mm), weight (g), and condition [(g · mm^{-3}) · (10^{5})] of juvenile coho salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern region													
Upper Chatham Strait	Length	141	111-253	178.8	2.0	72	153-258	211.0	2.7	19	141-271	235.9	6.8
	Weight	137	11.9-208.2	71.0	2.6	71	38.0-217.3	114.6	4.8	19	35.1-232.4	162.6	11.5
	Condition	137	0.8-1.3	1.2	0.0	71	1.0-1.3	1.2	0.0	19	1.0-1.3	1.2	0.0
Icy Strait	Length	122	121-243	194.3	1.9	34	162-243	205.4	3.1	25	186-292	241.0	5.1
	Weight	120	20.9-170.5	89.8	2.6	31	46.4-198.9	108.0	6.1	25	41.0-292.2	170.7	12.1
	Condition	120	0.5-2.2	1.2	0.0	31	1.1-1.6	1.2	0.0	25	1.1-1.4	1.2	0.0
Southern region													
Middle Clarence Strait	Length	58	113-221	183.8	2.9	24	177-233	196.9	2.7	—	—	—	—
	Weight	55	14.4-133.0	76.5	3.7	24	66.2-157.7	92.8	4.4	—	—	—	—
	Condition	55	0.8-1.6	1.2	0.0	24	0.9-1.7	1.2	0.0	—	—	—	—
Lower Clarence Strait	Length	125	120-226	179.0	2.0	25	164-242	207.2	3.9	—	—	—	—
	Weight	119	19.2-142.5	68.7	2.5	25	55.5-179.6	111.1	6.0	—	—	—	—
	Condition	119	0.8-1.7	1.1	0.0	25	1.1-1.4	1.2	0.0	—	—	—	—
Grand total													
	Length	446	111-253	183.8	1.1	155	153-258	207.0	1.7	44	141-292	238.8	4.1
	Weight	431	11.9-208.2	76.3	1.4	151	38.0-217.3	109.2	2.9	44	35.1-292.2	167.2	8.4
	Condition	431	0.5-2.2	1.2	0.0	151	0.9-1.7	1.2	0.0	44	1.0-1.4	1.2	0.0

Table 15.— Length (FL, mm), weight (g), and condition [(g · mm^{-3}) · (10^{5})] of juvenile Chinook salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						Northern region							
Upper	Length	5	183-266	209.6	14.6	1	296-296	296.0	0.0	—	—	—	—
Chatham	Weight	3	81.8-106.8	97.9	8.1	—	—	—	—	—	—	—	—
Strait	Condition	3	1.3-1.3	1.3	0.0	—	—	—	—	—	—	—	—
Icy	Length	4	178-261	205.8	18.9	5	205-271	244.2	11.8	1	255	255.0	0.0
Strait	Weight	4	63.3-229.6	115.1	38.9	4	127.2-271.3	219.8	31.8	1	223.1	223.1	0.0
	Condition	4	1.1-1.3	1.2	0.0	4	1.3-1.5	1.4	0.1	1	1.3	1.3	0.0
						Southern region							
Middle	Length	4	176-240	209.3	14.5	1	187	187.0	0.0	—	—	—	—
Clarence	Weight	2	62.0-118.5	90.3	28.3	1	76.7	76.7	0.0	—	—	—	—
Strait	Condition	2	1.0-1.1	1.1	0.1	1	1.2	1.2	0.0	—	—	—	—
Lower	Length	3	164-241	190.3	25.3	1	252	252.0	0.0	—	—	—	—
Clarence	Weight	3	51.2-130.3	79.3	25.5	—	—	—	—	—	—	—	—
Strait	Condition	3	0.9-1.2	1.1	0.1	—	—	—	—	—	—	—	—
Grand total													
	Length	16	164-266	204.9	8.1	8	187-296	244.5	12.6	1	255	255.0	0.0
	Weight	12	51.2-229.6	97.7	14.1	5	76.7-271.3	191.2	37.8	1	223.1	223.1	0.0
	Condition	12	0.9-1.3	1.2	0.0	5	1.2-1.5	1.4	0.1	1	1.3	1.3	0.0

Table 16.—Data on salmon lacking the adipose fin, with release and recovery information of Chinook and coho salmon containing a coded-wire tag and captured in marine waters of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Station code acronyms and coordinates are shown in Table 1.

		Release information						Recovery information							
Species	Coded-wire tag code	Brood year	Agency[1]	Locality	Date	FL (mm)	Wt (g)	Locality	Station code	Date	FL (mm)	Wt (g)	Age	Days[2] since release	Distance traveled (km)
						June									
Coho	04/1/5/8/6	2003	ADFG	Berners R.(wild), AK	5/10/04	38	—	U. Chatham	UCB	6/28/05	167	57.3	2.0	~414	83
Coho	04/1/5/9/7	2003	NRSAA	Indian R-Medvejie, AK	7/02/04	—	1.5	Icy Strait	ISB	7/01/05	197	103.6	2.0	~364	239
Coho	04:08/77	2003	ADFG	Berners River, AK	5/09/05	110	—	U. Chatham	UCD	6/28/05	175	65.6	1.0	50	78
Coho	04:08/77	2003	ADFG	Berners River, AK	5/09/05	110	—	U. Chatham	UCD	6/30/05	165	56.5	1.0	52	78
Coho	04:10/34	2003	NSRAA	Kasnyku Bay, AK	5/31/05	130	21.4	U. Chatham	UCC	6/28/05	194	81.3	1.0	28	112
Coho	04:10/83	2003	SSRAA	Neets Bay, AK	5/31/05	144	29.2	L. Clarence	LCD	6/25/05	161	43.8	1.0	25	78
Coho	04:10/86	2003	SSRAA	Herring Cove, AK	5/24/05	134	25.1	M. Clarence	MCA	6/23/05	151	51.4	1.0	30	45
Coho	04:10/93	2003	SSRAA	Nakat Inlet, AK	5/22/05	140	27.5	L. Clarence	LCC	6/25/05	185	71.0	1.0	34	109
Coho	04:11/42	2002	NMFS	Auke Creek, AK	5/31/05	115	15.0	Icy Strait	ISC	6/29/05	210	116.5	2.0	29	92
Coho	09:41/26	2003	ODFW	Big Creek, OR	5/01/05	—	11.7	L. Clarence	LCA	6/22/05	198	90.9	1.0	52	1,747
Coho	09:41/26	2003	ODFW	Big Creek, OR	5/01/05	—	11.7	L. Clarence	LCC	6/25/05	187	61.9	1.0	55	1,747
Coho	21:03/81	2003	QIN	Clearwater River, WA	10/4/04	—	57.9	L. Clarence	LCA	6/22/05	203	98.7	2.0	~261	1,250
Coho	63:26/82	2003	WDFW	Willapa Bay, WA	4/15/05	139	151.7	L. Clarence	LCA	6/22/05	192	93.6	1.0	68	1,140
Coho	63:27/70	2003	WDFW	Chehalis River, WA	4/04/05	—	—	M. Clarence	MCC	6/21/05	196	89.2	1.0	78	1,150
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCC	6/21/05	200	113.8	—	—	
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCC	6/21/05	205	99.5	—	—	
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/21/05	201	84.5	—	—	
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/21/05	221	123.8	—	—	
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/21/05	201	95.3	—	—	
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/21/05	113	14.5	—	—	
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/22/05	195	91.7	—	—	

Table 16.—cont.

		Release information						Recovery information							
Species	Coded-wire tag code	Brood year	Agency[1]	Locality	Date	FL (mm)	Wt (g)	Locality	Station code	Date	FL (mm)	Wt (g)	Age	Days[2] since release	Distance traveled (km)
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/22/05	226	142.8	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/22/05	198	97.5	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/22/05	219	115.6	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/22/05	194	84.4	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	195	90.3	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	191	79.7	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	209	109.2	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	197	85.7	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	188	76.1	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	205	104.2	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	202	91.2	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/22/05	204	99.5	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCD	6/23/05	193	83.6	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCD	6/23/05	197	86.2	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCD	6/23/05	201	101.8	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/23/05	190	111.0	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/23/05	217	86.9	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCB	6/23/05	214	101.8	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCA	6/23/05	196	96.0	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCA	6/23/05	187	79.0	—	—	—
Coho	No tag	—	—	—	—	—	—	M. Clarence	MCA	6/23/05	193	95.9	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/24/05	173	78.2	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCB	6/24/05	191	99.0	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCD	6/24/05	201	92.3	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCC	6/25/05	202	93.0	—	—	—

Table 16.—cont.

Species	Coded-wire tag code	Release information: Brood year	Agency[1]	Locality	Date	FL (mm)	Wt (g)	Recovery information: Locality	Station code	Date	FL (mm)	Wt (g)	Age	Days[2] since release	Distance traveled (km)
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCC	6/25/05	219	129.3	—	—	—
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCA	6/25/05	211	113.5	—	—	—
Chinook	03/22/71	2003	NMFS	Little Port Walter, AK	5/01/05	—	34.0	U. Chatham	UCC	6/30/05	266	238.4	1.0	60	212
Chinook	04:01/55	1999	DIPAC	Fish Creek, AK	6/13/01	—	24.3	U. Chatham	UCD	6/30/05	833	8500.0	1.4	1,478	59
Chinook	04:06/91	2003	NSRAA	Kasnyku Bay, AK	6/04/05	—	42.0	U. Chatham	UCD	6/30/05	193	94.1	1.0	26	112
Chinook	04:07/24	2001	DIPAC	Fish Creek, AK	6/12/03	—	23.9	U. Chatham	UCD	6/30/05	615	3050.0	1.2	742	59
Chinook	09:40/45	2003	ODFW	Deschutes River, OR	5/04/05	—	9.7	M. Clarence	MCC	6/23/05	240	155.2	1.0	73	1,494
Chinook	No tag	—	—	—	—	—	—	M. Clarence	MCC	6/21/05	195	95.1	—	96	—
Chinook	No tag	—	—	—	—	—	—	L. Clarence	LCD	6/22/05	241	133.8	—	73	—
Chinook	No tag	—	—	—	—	—	—	Icy Strait	ISC	6/29/05	261	231.2	—	67	—
								July							
Coho	04:10/11	2003	ADFG	Canyon Island, AK	5/15/05	98	10.7	U. Chatham	UCD	7/27/05	210	118.5	1.0	73	155
Coho	04:11/33	2003	ADFG	Chilkat R. (wild), AK	4/26/05	—	—	Icy Strait	ISD	7/31/05	208	104.8	1.0	96	150
Coho	No tag	—	—	—	—	—	—	L. Clarence	LCC	7/23/05	225	139.2	—	—	—
Coho	No tag	—	—	—	—	—	—	U. Chatham	UCD	7/27/05	206	105.1	—	—	—
Chinook	03:22/69	2003	NMFS	Little Port Walter, AK	5/19/05	—	24.0	Icy Strait	ISA	7/31/05	231	17.0	1.0	73	238
Chinook	04:09/53	2003	AKI	Port Armstrong, AK	5/21/05	165	52.8	U. Chatham	UCD	7/27/05	296	352.3	1.0	67	226
Chinook	09:39/32	2003	ODFW	Willamette River, OR	4/04/05	—	13.2	L. Clarence	LCB	7/21/05	252	183.7	1.0	108	1,224
								August							
Coho	04:11/22	2003	DIPAC	Sheep Creek, AK	6/10/05	—	15.3	Icy Strait	ISB	8/25/05	259	199.3	1.0	41	133

[1] ADFG = Alaska Department of Fish and Game; AKI = Armstrong Keta Inc.; DIPAC = Douglas Island Pink and Chum; NMFS = National Marine Fisheries Service; NSRAA = Northern Southeast Regional Aquaculture Association; ODFW = Oregon Department of Fish and Wildlife; QIN = Quinault Indian Nation; SSRAA = Southern Southeast Regional Aquaculture Association.

[2] Days since release may potentially include freshwater residence periods.

Table 17.—Stock-specific information on juvenile chum salmon released from regional enhancement facilities and captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length (FL, mm), weight (g), and condition [(g · mm^{-3}) · (10^{5})] are reported for each stock group by range, mean, standard error (se) of the mean along with sample size (*n*). *No fish released from hatcheries in the northern region were captured in the southern region; however, fish released from the southern region were captured in the northern region. See table 16 for agency acronyms. Abbreviations: ER = Early Regular, LL = Late Large.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						Northern region*							
						DIPAC							
						Amalga Harbor ER							
Upper	Length	16	97-126	113.1	2.0	—	—	—	—	2	209-211	210.0	1.0
Chatham	Weight	16	9.0-19.2	13.7	0.7	—	—	—	—	2	88.3-97.4	92.8	4.5
Strait	Condition	16	0.8-1.0	0.9	0.0	—	—	—	—	2	1.0-1.0	1.0	0.0
Icy	Length	21	102-140	120.8	2.9	—	—	—	—	3	185-207	199.0	7.0
Strait	Weight	21	9.8-27.8	18.0	1.4	—	—	—	—	3	71.8-97.9	88.8	8.5
	Condition	21	0.9-1.1	1.0	0.0	—	—	—	—	3	1.1-1.1	1.1	0.0
Total	Length	37	97-140	117.5	1.9	—	—	—	—	5	185-211	203.4	4.7
	Weight	37	9.0-27.8	16.2	0.9	—	—	—	—	5	71.8-97.9	90.4	5.0
	Condition	37	0.8-1.1	1.0	0.0	—	—	—	—	5	1.0-1.1	1.1	0.0
						Amalga Harbor LL							
Upper	Length	5	95-121	108.8	4.5	—	—	—	—	1	186	186.0	0.0
Chatham	Weight	5	7.9-18.1	12.7	1.8	—	—	—	—	1	74.8	74.8	0.0
Strait	Condition	5	0.9-1.0	1.0	0.0	—	—	—	—	1	1.2	1.2	0.0

Table 17.—(Cont.)

Locality	Factor	June *n*	June range	June mean	June se	July *n*	July range	July mean	July se	August *n*	August range	August mean	August se
Icy Strait	Length	7	98-141	121.1	5.5	—	—	—	—	—	—	—	—
	Weight	7	8.7-31.3	19.0	2.8	—	—	—	—	—	—	—	—
	Condition	7	0.9-1.1	1.0	0.0	—	—	—	—	—	—	—	—
Total	Length	12	95-141	116.0	4.0	—	—	—	—	1	186	186.0	0.0
	Weight	12	7.9-31.3	16.4	1.9	—	—	—	—	1	74.8	74.8	0.0
	Condition	12	0.9-1.1	1.0	0.0	—	—	—	—	1	1.2	1.2	0.0
Boat Harbor ER													
Upper Chatham Strait	Length	5	107-121	112.4	2.6	—	—	—	—	—	—	—	—
	Weight	5	11.2-16.9	13.6	1.0	—	—	—	—	—	—	—	—
	Condition	5	0.9-1.0	1.0	0.0	—	—	—	—	—	—	—	—
Icy Strait	Length	18	100-131	117.1	2.6	—	—	—	—	3	179-186	183.7	2.3
	Weight	18	10.3-25.4	16.2	1.1	—	—	—	—	3	65.7-66.9	66.4	0.4
	Condition	18	0.8-1.1	1.0	0.0	—	—	—	—	3	1.0-1.2	1.1	0.0
Total	Length	23	100-131	116.0	2.1	—	—	—	—	3	179-186	183.7	2.3
	Weight	23	10.3-25.4	15.6	0.9	—	—	—	—	3	65.7-66.9	66.4	0.4
	Condition	23	0.8-1.1	1.0	0.0	—	—	—	—	3	1.0-1.2	1.1	0.0
Gastineau Channel ER													
Upper Chatham Strait	Length	10	109-125	118.2	1.8	1	129	129.0	0.0	2	188-201	194.5	6.5
	Weight	10	12.9-20.8	16.0	0.8	1	21.1	21.1	0.0	2	76.8-102.6	89.7	12.9
	Condition	10	0.8-1.1	1.0	0.8	1	1.0	1.0	0.0	2	1.2-1.3	1.2	12.9

Table 17.—(Cont.)

Locality	Factor	June n	June range	June mean	June se	July n	July range	July mean	July se	August n	August range	August mean	August se
Icy Strait	Length	7	117-133	122.0	2.1	1	163	163.0	0.0	1	171	171.0	0.0
	Weight	7	14.2-23.4	17.6	1.1	1	42.8	42.8	0.0	1	54.9	54.9	0.0
	Condition	7	0.9-1.0	1.0	1.1	1	1.0	1.0	0.0	1	1.1	1.1	0.0
Total	Length	17	109-133	119.8	1.4	2	129-163	146.0	17.0	3	171-201	186.7	8.7
	Weight	17	12.9-23.4	16.7	0.7	2	21.1-42.8	32.0	10.9	3	54.9-102.6	78.1	13.8
	Condition	17	0.8-1.1	1.0	0.7	2	1.0-1.0	1.0	10.9	3	1.1-1.3	1.2	13.8
						Gastineau Channel LL							
Upper Chatham Strait	Length	11	85-124	112.5	3.3	—	—	—	—	—	—	—	—
	Weight	11	5.4-22.7	14.3	1.4	—	—	—	—	—	—	—	—
	Condition	11	0.8-1.2	1.0	0.0	—	—	—	—	—	—	—	—
Icy Strait	Length	24	99-135	114.3	1.9	2	99-148	123.5	24.5	—	—	—	—
	Weight	24	10.0-24.0	15.0	0.8	2	9.5-30.4	20.0	10.5	—	—	—	—
	Condition	24	0.8-1.2	1.0	0.0	2	0.9-1.0	1.0	0.0	—	—	—	—
Total	Length	35	85-135	113.7	1.6	2	99-148	123.5	24.5	—	—	—	—
	Weight	35	5.4-24.0	14.8	0.7	2	9.5-30.4	20.0	10.5	—	—	—	—
	Condition	35	0.8-1.2	1.0	0.0	2	0.9-1.0	1.0	0.0	—	—	—	—
						Limestone							
Upper Chatham Strait	Length	5	111-126	119.8	2.6	—	—	—	—	—	—	—	—
	Weight	5	13.4-19.0	16.8	0.9	—	—	—	—	—	—	—	—
	Condition	5	0.9-1.0	1.0	0.0	—	—	—	—	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Icy	Length	8	104-126	116.6	2.8	1	170	170.0	0.0	2	175-195	185.0	10.0
Strait	Weight	8	11.7-20.2	16.2	1.1	1	46.3	46.3	0.0	2	60.4-91.3	75.9	15.5
	Condition	8	0.9-1.1	1.0	0.0	1	0.9	0.9	0.0	2	1.1-1.2	1.2	0.1
Total	Length	13	104-126	117.8	2.0	1	170	170.0	0.0	2	175-195	185.0	10.0
	Weight	13	11.7-20.2	16.4	0.7	1	46.3	46.3	0.0	2	60.4-91.3	75.9	15.5
	Condition	13	0.9-1.1	1.0	0.0	1	0.9	0.9	0.0	2	1.1-1.2	1.2	0.1
						NSRAA							
						Kasnyku Bay ER							
Upper	Length	8	97-113	107.1	1.9	2	113-128	120.5	7.5	1	169	169.0	0.0
Chatham	Weight	8	8.4-13.5	11.4	0.6	2	13.5-19.2	16.3	2.8	1	47.1	47.1	0.0
Strait	Condition	8	0.9-1.0	0.9	0.0	2	0.9-0.9	0.9	0.0	1	1.0	1.0	0.0
Icy	Length	33	96-137	114.5	1.7	10	111-145	123.8	3.3	1	163	163.0	0.0
Strait	Weight	33	8.5-26.6	14.9	0.8	10	11.7-31.5	18.3	1.9	1	52.2	52.2	0.0
	Condition	33	0.9-1.1	1.0	0.0	10	0.8-1.0	0.9	0.0	1	1.2	1.2	0.0
Total	Length	41	96-137	113.0	1.5	12	111-145	123.3	2.9	2	163-169	166.0	3.0
	Weight	41	8.4-26.6	14.2	0.7	12	11.7-31.5	18.0	1.6	2	47.1-52.2	49.6	2.6
	Condition	41	0.9-1.1	1.0	0.0	12	0.8-1.0	0.9	0.0	2	1.0-1.2	1.1	0.1
						Kasnyku Bay LL							
Upper	Length	—	—	—	—	—	—	—	—	—	—	—	—
Chatham	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June *n*	June range	June mean	June se	July *n*	July range	July mean	July se	August *n*	August range	August mean	August se
Icy Strait	Length	2	113-117	115.0	2.0	1	123	123.0	0.0	1	188	188.0	0.0
	Weight	2	13.3-15.7	14.5	1.2	1	16.4	16.4	0.0	1	65.7	65.7	0.0
	Condition	2	0.9-1.0	0.9	0.0	1	0.9	0.9	0.0	1	1.0	1.0	0.0
Takatz Bay													
Upper Chatham Strait	Length	17	94-117	106.5	1.5	—	—	—	—	—	—	—	—
	Weight	17	7.7-15.3	11.3	0.5	—	—	—	—	—	—	—	—
	Condition	17	0.8-1.1	0.9	0.0	—	—	—	—	—	—	—	—
Icy Strait	Length	51	96-131	113.7	1.2	7	117-155	137.1	4.3	1	192	192.0	0.0
	Weight	51	8.5-24.8	14.4	0.5	7	13.8-36.0	25.4	2.6	1	70.0	70.0	0.0
	Condition	51	0.8-1.1	1.0	0.0	7	0.9-1.1	1.0	0.0	1	1.0	1.0	0.0
Total	Length	68	94-131	111.9	1.0	7	117-155	137.1	4.3	1	192	192.0	0.0
	Weight	68	7.7-24.8	13.6	0.4	7	13.8-36.0	25.4	2.6	1	70.0	70.0	0.0
	Condition	68	0.8-1.1	1.0	0.0	7	0.9-1.1	1.0	0.0	1	1.0	1.0	0.0
Southern region*													
SSRAA Anita Bay													
Upper Chatham Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Icy	Length	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Middle	Length	12	71-103	92.1	2.3	2	111-138	124.5	13.5	—	—	—	—
Clarence	Weight	12	6.2-9.9	7.8	0.3	2	12.9-26.8	19.8	6.9	—	—	—	—
Strait	Condition	12	0.9-1.9	1.0	0.1	2	0.9-1.0	1.0	0.0	—	—	—	—
Lower	Length	6	99-117	107.8	3.0	2	123-135	129.0	6.0	—	—	—	—
Clarence	Weight	6	8.2-14.9	11.5	1.1	2	18.6-23.3	20.9	2.3	—	—	—	—
Strait	Condition	6	0.8-1.0	0.9	0.0	2	0.9-1.0	1.0	0.0	—	—	—	—
Total	Length	18	71-117	97.3	2.5	4	111-138	126.8	6.2	—	—	—	—
	Weight	18	6.2-14.9	9.0	0.6	4	12.9-26.8	20.4	3.0	—	—	—	—
	Condition	18	0.8-1.9	1.0	0.1	4	0.9-1.0	1.0	0.0	—	—	—	—
						Kendrick Bay							
Upper	Length	—	—	—	—	—	—	—	—	2	190-197	193.5	3.5
Chatham	Weight	—	—	—	—	—	—	—	—	2	80.6-82	81.3	0.7
Strait	Condition	—	—	—	—	—	—	—	—	2	1.1-1.2	1.1	0.1
Icy	Length	—	—	—	—	—	—	—	—	1	209	209.0	0.0
Strait	Weight	—	—	—	—	—	—	—	—	1	101.4	101.4	0.0
	Condition	—	—	—	—	—	—	—	—	1	1.1	1.1	0.0
Middle	Length	10	111-127	116.5	1.6	1	132	132.0	0.0	—	—	—	—
Clarence	Weight	10	12.3-19.0	15.0	0.6	1	20.3	20.3	0.0	—	—	—	—
Strait	Condition	10	0.9-1.1	0.9	0.0	1	0.9	0.9	0.0	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Lower	Length	3	92-113	103.7	6.2	3	126-150	138.3	6.9	—	—	—	—
Clarence	Weight	3	5.5-13.9	10.1	2.5	3	16.8-30.1	24.3	3.9	—	—	—	—
Strait	Condition	3	0.7-1.0	0.9	0.1	3	0.8-1.0	0.9	0.0	—	—	—	—
Total	Length	13	92-127	113.5	2.3	4	126-150	136.8	5.2	3	190-209	198.7	5.5
	Weight	13	5.5-19.0	13.9	0.9	4	16.8-30.1	23.3	3.0	3	80.6-101.4	88.0	6.7
	Condition	13	0.7-1.1	0.9	0.0	4	0.8-1.0	0.9	0.0	3	1.1-1.2	1.1	0.0
Nakat Inlet (summer)													
Upper	Length	—	—	—	—	—	—	—	—	—	—	—	—
Chatham	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Icy	Length	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Middle	Length	1	123	123.0	0.0	—	—	—	—	—	—	—	—
Clarence	Weight	1	16.2	16.2	0.0	—	—	—	—	—	—	—	—
Strait	Condition	1	0.9	0.9	0.0	—	—	—	—	—	—	—	—
Lower	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	1	123	123.0	0.0	—	—	—	—	—	—	—	—
	Weight	1	16.2	16.2	0.0	—	—	—	—	—	—	—	—
	Condition	1	0.9	0.9	0.0	—	—	—	—	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						Nakat Inlet (fall)							
Upper	Length	—	—	—	—	—	—	—	—	—	—	—	—
Chatham	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Icy	Length	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Middle	Length	1	119	119.0	0.0	—	—	—	—	—	—	—	—
Clarence	Weight	1	17.6	17.6	0.0	—	—	—	—	—	—	—	—
Strait	Condition	1	1.0	1.0	0.0	—	—	—	—	—	—	—	—
Lower	Length	1	97-97	97.0	0.0	—	—	—	—	—	—	—	—
Clarence	Weight	1	7.8-7.8	7.8	0.0	—	—	—	—	—	—	—	—
Strait	Condition	1	0.9-0.9	0.9	0.0	—	—	—	—	—	—	—	—
Total	Length	2	97-119	108.0	11.0	—	—	—	—	—	—	—	—
	Weight	2	7.8-17.6	12.7	4.9	—	—	—	—	—	—	—	—
	Condition	2	0.9-1.0	0.9	0.1	—	—	—	—	—	—	—	—
						Neets Bay (summer)							
Upper	Length	—	—	—	—	—	—	—	—	1	171	171.0	0.0
Chatham	Weight	—	—	—	—	—	—	—	—	1	51.2	51.2	0.0
Strait	Condition	—	—	—	—	—	—	—	—	1	1.0	1.0	0.0

Table 17.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Icy Strait	Length	—	—	—	—	—	—	—	—	2	205-215	210.0	5.0
	Weight	—	—	—	—	—	—	—	—	2	101.9-110.5	106.2	4.3
	Condition	—	—	—	—	—	—	—	—	2	1.1-1.2	1.1	0.0
Middle Clarence Strait	Length	47	71-127	102.0	2.2	5	111-150	125.6	6.7	—	—	—	—
	Weight	47	4.1-20.5	10.5	0.6	5	12.4-31.2	19.6	3.2	—	—	—	—
	Condition	47	0.5-1.5	1.0	0.0	5	0.9-1.0	1.0	0.0	—	—	—	—
Lower Clarence Strait	Length	26	81-129	101.4	2.2	13	107-157	125.5	3.9	—	—	—	—
	Weight	26	4.5-20.6	10.0	0.8	13	11.7-37.4	19.1	2.1	—	—	—	—
	Condition	26	0.5-1.6	0.9	0.0	13	0.8-1.0	0.9	0.0	—	—	—	—
Total	Length	73	71-129	101.8	1.6	18	107-157	125.6	3.3	3	171-215	197.0	13.3
	Weight	73	4.1-20.6	10.3	0.5	18	11.7-37.4	19.2	1.7	3	51.2-110.5	87.9	18.5
	Condition	73	0.5-1.6	0.9	0.0	18	0.8-1.0	0.9	0.0	3	1.0-1.2	1.1	0.0
Neets Bay (fall)													
Upper Chatham Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Icy Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Middle Clarence Strait	Length	54	67-112	87.4	1.6	6	115-123	117.7	1.2	—	—	—	—
	Weight	54	3.8-16.7	6.8	0.3	6	13.5-16.9	15.0	0.5	—	—	—	—
	Condition	54	0.5-1.8	1.0	0.0	6	0.8-1.0	0.9	0.0	—	—	—	—

Table 17.—(Cont.)

Locality	Factor	June *n*	June range	June mean	June se	July *n*	July range	July mean	July se	August *n*	August range	August mean	August se
Lower	Length	19	75-105	93.5	1.6	21	107-129	119.3	1.0	—	—	—	—
Clarence	Weight	19	4.1-11.6	7.5	0.4	21	12.2-23.2	16.4	0.5	—	—	—	—
Strait	Condition	19	0.7-1.4	0.9	0.0	21	0.8-1.1	1.0	0.0	—	—	—	—
Total	Length	73	67-112	89.0	1.3	27	107-129	118.9	0.8	—	—	—	—
	Weight	73	3.8-16.7	7.0	0.3	27	12.2-23.2	16.1	0.4	—	—	—	—
	Condition	73	0.5-1.8	1.0	0.0	27	0.8-1.1	1.0	0.0	—	—	—	—
Northern and Southern regions													
Unmarked													
Upper	Length	36	85-137	106.1	2.1	32	95-157	122.1	2.8	31	149-219	192.5	3.3
Chatham	Weight	36	5.3-25.9	11.6	0.7	32	6.9-36.4	16.7	1.3	31	32.8-120.8	81.6	4.2
Strait	Condition	36	0.7-1.1	0.9	0.0	32	0.7-1.0	0.9	0.0	31	0.9-1.3	1.1	0.0
Icy	Length	57	91-145	114.2	1.5	31	102-146	119.2	1.9	40	142-225	188.9	3.5
Strait	Weight	57	6.8-28.7	15.0	0.7	31	9.6-32.4	15.9	0.9	40	23.2-132.2	76.6	4.7
	Condition	57	0.8-1.2	1.0	0.0	31	0.8-1.0	0.9	0.0	40	0.3-1.3	1.1	0.0
Middle	Length	90	69-133	91.1	1.4	21	91-168	120.7	3.5	—	—	—	—
Clarence	Weight	90	2.7-22.8	7.5	0.4	21	7.1-44.4	17.2	1.8	—	—	—	—
Strait	Condition	90	0.4-1.8	0.9	0.0	21	0.7-1.1	0.9	0.0	—	—	—	—
Lower	Length	46	65-170	94.3	2.3	26	103-189	122.3	3.1	—	—	—	—
Clarence	Weight	46	2.9-48.2	7.8	1.0	26	10.9-66.0	18.6	2.1	—	—	—	—
Strait	Condition	46	0.4-2.0	0.9	0.0	26	0.9-1.1	1.0	0.0	—	—	—	—

Table 17.—(Cont.)

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Total	Length	229	65-170	99.8	1.1	110	91-189	121.1	1.4	71	142-225	190.5	2.4
	Weight	229	2.7-48.2	10.1	0.4	110	6.9-66.0	17.0	0.8	71	23.2-132.2	78.8	3.2
	Condition	229	0.4-2.0	0.9	0.0	110	0.7-1.1	0.9	0.0	71	0.3-1.3	1.1	0.0

Table 18.—Stock-specific information on juvenile sockeye salmon released from regional enhancement facilities and captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length (mm, fork), weight (g), and condition [(g · mm^{-3}) · (10^5)] are reported for each stock group by range, mean, standard error (se) of the mean along with sample size (*n*). See table 16 for agency acronyms. Abbreviations: ES = early small, EL = early large, LS = late small, LL = late large.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						Northern region							
						DIPAC Tahltan Lake							
Upper Chatham Strait	Length	3	129-141	134.3	3.5	—	—	—	—	—	—	—	—
	Weight	3	18.4-25.9	22.5	2.2	—	—	—	—	—	—	—	—
	Condition	3	0.9-1.0	0.9	0.0	—	—	—	—	—	—	—	—
Icy Strait	Length	2	115-131	123.0	8.0	—	—	—	—	—	—	—	—
	Weight	2	14.3-19.4	16.8	2.5	—	—	—	—	—	—	—	—
	Condition	2	0.9-0.9	0.9	0.0	—	—	—	—	—	—	—	—
Middle Clarence Strait	Length	1	98	98.0	0.0	—	—	—	—	—	—	—	—
	Weight	1	7.1	7.1	0.0	—	—	—	—	—	—	—	—
	Condition	1	0.8	0.8	0.0	—	—	—	—	—	—	—	—
Lower Clarence Strait	Length	2	105-110	107.5	2.5	—	—	—	—	—	—	—	—
	Weight	2	7.9-10.3	9.1	1.2	—	—	—	—	—	—	—	—
	Condition	2	0.7-0.8	0.7	0.0	—	—	—	—	—	—	—	—
Total	Length	8	98-141	120.3	5.4	—	—	—	—	—	—	—	—
	Weight	8	7.1-25.9	15.8	2.5	—	—	—	—	—	—	—	—
	Condition	8	0.7-1.0	0.8	0.0	—	—	—	—	—	—	—	—

Table 18.—(Cont.)

Locality	Factor	June *n*	June range	June mean	June se	July *n*	July range	July mean	July se	August *n*	August range	August mean	August se
						Tatsamenie Lake							
Upper Chatham Strait	Length	3	111-124	117.0	3.8	1	154	154.0	0.0	—	—	—	—
	Weight	3	12.6-18.2	15.0	1.7	1	33.0	33.0	0.0	—	—	—	—
	Condition	3	0.9-1.0	0.9	0.0	1	0.9	0.9	0.0	—	—	—	—
Icy Strait	Length	12	103-137	115.7	2.8	—	—	—	—	—	—	—	—
	Weight	12	8.9-24.1	14.9	1.3	—	—	—	—	—	—	—	—
	Condition	12	0.8-1.1	0.9	0.0	—	—	—	—	—	—	—	—
Middle Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	15	103-137	115.9	2.3	1	154	154.0	0.0	—	—	—	—
	Weight	15	8.9-24.1	14.9	1.0	1	33.0	33.0	0.0	—	—	—	—
	Condition	15	0.8-1.1	0.9	0.0	1	0.9	0.9	0.0	—	—	—	—
						Port Snettisham ES							
Upper Chatham Strait	Length	12	121-150	132.1	2.7	—	—	—	—	1	197	197.0	0.0
	Weight	12	18.3-36.1	24.1	1.5	—	—	—	—	1	87.2	87.2	0.0
	Condition	12	0.9-1.2	1.0	0.0	—	—	—	—	1	1.1	1.1	0.0

Table 18.—(Cont.)

Locality	Factor	June n	June range	June mean	June se	July n	July range	July mean	July se	August n	August range	August mean	August se
Icy Strait	Length	4	115-145	127.3	6.5	—	—	—	—	—	—	—	—
	Weight	4	16-33.2	22.1	3.8	—	—	—	—	—	—	—	—
	Condition	4	1.0-1.1	1.0	0.0	—	—	—	—	—	—	—	—
Middle	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	16	115-150	130.9	2.5	—	—	—	—	1	197	197.0	0.0
	Weight	16	16-36.1	23.6	1.4	—	—	—	—	1	87.2	87.2	0.0
	Condition	16	0.9-1.2	1.0	0.0	—	—	—	—	1	1.1	1.1	0.0
						Port Snettisham EL							
Upper	Length	6	123-155	136.3	4.4	1	156	156.0	0.0	1	156	190.0	0.0
Chatham	Weight	6	18.6-36.1	26.4	2.4	1	40.1	40.1	0.0	1	40.1	76.9	0.0
Strait	Condition	6	1.0-1.1	1.0	0.0	1	1.1	1.1	0.0	1	1.1	1.1	0.0
Icy Strait	Length	4	129-147	138.8	3.7	—	—	—	—	—	—	—	—
	Weight	4	22.8-32.4	29.2	2.2	—	—	—	—	—	—	—	—
	Condition	4	1.0-1.2	1.1	0.0	—	—	—	—	—	—	—	—
Middle	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—

Table 18.—(Cont.)

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Lower Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	10	123-155	137.3	2.9	1	156	156.0	0.0	1	156	190.0	0.0
	Weight	10	18.6-36.1	27.5	1.7	1	40.1	40.1	0.0	1	40.1	76.9	0.0
	Condition	10	1.0-1.2	1.1	0.0	1	1.1	1.1	0.0	1	1.1	1.1	0.0
						Port Snettisham LS							
Upper Chatham Strait	Length	7	105-147	126.7	5.1	—	—	—	—	1	184	184.0	0.0
	Weight	7	10.8-32	21.3	2.5	—	—	—	—	1	64.4	64.4	0.0
	Condition	7	0.9-1.1	1.0	0.0	—	—	—	—	1	1.0	1.0	0.0
Icy Strait	Length	2	111-120	115.5	4.5	1	165	165.0	0.0	—	—	—	—
	Weight	2	13.7-19.4	16.5	2.9	1	45.1	45.1	0.0	—	—	—	—
	Condition	2	1-1.1	1.1	0.1	1	1.0	1.0	0.0	—	—	—	—
Middle Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	9	105-147	124.2	4.3	1	165	165.0	0.0	1	184	184.0	0.0
	Weight	9	10.8-32	20.2	2.1	1	45.1	45.1	0.0	1	64.4	64.4	0.0
	Condition	9	0.9-1.1	1.0	0.0	1	1.0	1.0	0.0	1	1.0	1.0	0.0

Table 18.—(Cont.)

Locality	Factor	June n	June range	June mean	June se	July n	July range	July mean	July se	August n	August range	August mean	August se
						Port Snettisham LL							
Upper	Length	1	131	131.0	0.0	—	—	—	—	1	185	185.0	0.0
Chatham	Weight	1	24.2	24.2	0.0	—	—	—	—	1	65.1	65.1	0.0
Strait	Condition	1	1.1	1.1	0.0	—	—	—	—	1	1.0	1.0	0.0
Icy Strait	Length	2	129-135	132.0	3.0	1	164	164.0	0.0	—	—	—	—
	Weight	2	20.6-25.1	22.9	2.3	1	44.9	44.9	0.0	—	—	—	—
	Condition	2	1.0-1.0	1.0	0.0	1	1.0	1.0	0.0	—	—	—	—
Middle	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	3	129-135	131.7	1.8	1	164	164.0	0.0	1	185	185.0	0.0
	Weight	3	20.6-25.1	23.3	1.4	1	44.9	44.9	0.0	1	65.1	65.1	0.0
	Condition	3	1.0-1.1	1.0	0.0	1	1.0	1.0	0.0	1	1.0	1.0	0.0
						Northern and Southern regions							
						Unmarked							
Upper	Length	42	85-148	109.9	2.5	13	76-116	100.5	3.5	6	169-184	176.7	2.3
Chatham	Weight	42	5.4-34.8	13.4	1.0	13	3.6-14.8	9.6	1.0	6	49.9-72.7	60.0	4.0
Strait	Condition	42	0.7-1.1	0.9	0.0	13	0.8-1.0	0.9	0.0	6	0.9-1.2	1.1	0.0

Table 18.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Icy Strait	Length	73	82-173	116.2	2.0	8	93-136	107.5	4.9	5	172-182	178.0	2.0
	Weight	73	5.4-55.8	16.9	1.0	8	7.5-25.4	12.7	2.0	5	49.8-63.4	57.2	2.3
	Condition	73	0.8-1.1	1.0	0.0	8	0.9-1.0	1.0	0.0	5	0.9-1.1	1.0	0.0
Middle	Length	71	67-163	108.4	2.4	9	119-152	132.9	3.9	—	—	—	—
Clarence	Weight	71	3.7-42.3	13.8	1.1	9	15.8-33.5	23.7	2.2	—	—	—	—
Strait	Condition	71	0.5-1.4	1.0	0.0	9	0.9-1.2	1.0	0.0	—	—	—	—
Lower	Length	79	77-150	113.5	1.7	10	125-161	139.1	3.2	—	—	—	—
Clarence	Weight	79	3.4-33.6	14.0	0.7	10	18.0-47.7	28.2	2.6	—	—	—	—
Strait	Condition	79	0.5-2.7	0.9	0.0	10	0.9-1.1	1.0	0.0	—	—	—	—
Total	Length	265	67-173	112.3	1.1	40	76-161	118.9	3.3	11	169-184	177.3	1.5
	Weight	265	3.4-55.8	14.7	0.5	40	3.6-47.7	18.0	1.6	11	49.8-72.7	58.8	2.3
	Condition	265	0.5-2.7	1.0	0.0	40	0.8-1.2	1.0	0.0	11	1.0-1.2	1.1	0.0

Table 19.—Stock-specific information on juvenile coho salmon released from regional enhancement facilities and captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length (mm, fork), weight (g), and condition [$(g \cdot mm^{-3}) \cdot (10^5)$] are reported for each stock group by range, mean, standard error (se) of the mean along with sample size (*n*). See table 16 for agency acronyms.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern region													
DIPAC Gastineau Channel													
Upper Chatham Strait	Length	10	111-157	138.0	5.0	5	167-201	181.0	5.9	—	—	—	—
	Weight	10	11.9-46.8	29.6	3.7	5	49.8-91.7	65.5	7.0	—	—	—	—
	Condition	10	0.9-1.2	1.1	0.0	5	1.0-1.1	1.1	0.0	—	—	—	—
Icy Strait	Length	—	—	—	—	1	203	203.0	0.0	3	209-259	228.0	16.0
	Weight	—	—	—	—	1	98.6	98.6	0.0	3	110.0-198.6	141.4	28.6
	Condition	—	—	—	—	1	1.2	1.2	0.0	3	1.1-1.2	1.2	0.0
Middle Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	10	111-157	138.0	5.0	6	167-203	185.0	6.0	3	209-259	228.0	16.0
	Weight	10	11.9-46.8	29.6	3.7	6	49.8-98.6	71.1	8.0	3	110.0-198.6	141.4	28.6
	Condition	10	0.9-1.2	1.1	0.0	6	1.0-1.2	1.1	0.0	3	1.1-1.2	1.2	0.0

Table 19.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
						NSRAA							
						Medvejie Lake							
Upper Chatham Strait	Length	2	185-204	194.5	9.5	1	246	246.0	0.0	—	—	—	—
	Weight	2	72.3-109.0	90.7	18.4	1	177.5	177.5	0.0	—	—	—	—
	Condition	2	1.1-1.3	1.2	0.1	1	1.2	1.2	0.0	—	—	—	—
Icy Strait	Length	1	195	195.0	0.0	—	—	—	—	1	261	261.0	0.0
	Weight	1	87.1	87.1	0.0	—	—	—	—	1	223.2	223.2	0.0
	Condition	1	1.2	1.2	0.0	—	—	—	—	1	1.3	1.3	0.0
Middle Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower Clarence Strait	Length	—	—	—	—	—	—	—	—	—	—	—	—
	Weight	—	—	—	—	—	—	—	—	—	—	—	—
	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	3	185-204	194.7	5.5	1	246	246.0	0.0	1	261	261.0	0.0
	Weight	3	72.3-109.0	89.5	10.7	1	177.5	177.5	0.0	1	223.2	223.2	0.0
	Condition	3	1.1-1.3	1.2	0.0	1	1.2	1.2	0.0	1	1.3	1.3	0.0
						Northern and Southern regions							
						Unmarked							
Upper Chatham Strait	Length	125	121-253	181.9	1.9	64	153-258	212.5	2.8	19	141-271	235.9	6.8
	Weight	125	20.2-208.2	74.0	2.6	64	38.0-217.3	117.0	4.9	19	35.1-232.4	163.0	12.0
	Condition	125	0.7-1.3	1.2	0.0	64	1.0-1.3	1.2	0.0	19	1.0-1.3	1.2	0.0

Table 19.—(Cont.)

Locality	Factor	June *n*	June range	June mean	June se	July *n*	July range	July mean	July se	August *n*	August range	August mean	August se
Icy Strait	Length	119	121-243	194.1	1.9	30	162-243	204.8	3.4	20	186-292	242.4	5.8
	Weight	119	20.9-170.5	90.0	2.6	30	46.4-198.9	108.0	6.3	20	75.1-292.2	179.0	12.5
	Condition	119	0.5-2.2	1.2	0.0	30	1.1-1.6	1.2	0.0	20	1.1-1.4	1.2	0.0
Middle	Length	55	113-221	184.0	3.0	24	177-233	196.9	2.7	—	—	—	—
Clarence	Weight	55	14.4-133.0	77.0	3.7	24	66.2-157.7	92.8	4.4	—	—	—	—
Strait	Condition	55	0.8-1.6	1.2	0.0	24	0.9-1.7	1.2	0.0	—	—	—	—
Lower	Length	119	120-226	178.6	2.1	25	164-242	207.2	3.9	—	—	—	—
Clarence	Weight	119	19.2-142.5	69.0	2.5	25	55.5-179.6	111.0	6.0	—	—	—	—
Strait	Condition	119	0.8-1.7	1.1	0.0	25	1.1-1.4	1.2	0.0	—	—	—	—
Total	Length	418	113-253	184.7	1.1	143	153-258	207.3	1.7	39	141-292	239.2	4.4
	Weight	418	14.4-208.2	77.0	1.4	143	38.0-217.3	110.0	2.9	39	35.1-292.2	171.0	8.5
	Condition	418	0.5-2.2	1.2	0.0	143	0.9-1.7	1.2	0.0	39	1.0-1.4	1.2	0.0

Table 20.—Stock-specific information on juvenile Chinook salmon released from regional enhancement facilities and captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length (mm, fork), weight (g), and condition [(g · mm^{-3}) · (10^{5})] are reported for each stock group by range, mean, standard error (se) of the mean along with sample size (*n*). See table 16 for agency acronyms.

		June				July				August			
Locality	Factor	*n*	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern region													
NSRAA Hidden Falls													
Upper	Length	2	183-203	193.0	10.0	—	—	—	—	—	—	—	—
Chatham	Weight	2	81.8-106.8	94.3	12.5	—	—	—	—	—	—	—	—
Strait	Condition	2	1.3-1.3	1.3	0.0	—	—	—	—	—	—	—	—
Icy	Length	3	178-199	187.0	6.2	4	205-271	248.0	15.0	—	—	—	—
Strait	Weight	3	63.3-98.3	76.9	10.8	4	127.2-271.3	219.8	31.8	—	—	—	—
	Condition	3	1.1-1.2	1.2	0.0	4	1.3-1.5	1.4	0.1	—	—	—	—
Middle	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Lower	Length	—	—	—	—	—	—	—	—	—	—	—	—
Clarence	Weight	—	—	—	—	—	—	—	—	—	—	—	—
Strait	Condition	—	—	—	—	—	—	—	—	—	—	—	—
Total	Length	5	178-203	190.0	4.8	4	205-271	248.0	15.0	—	—	—	—
	Weight	5	63.3-106.8	83.9	8.3	4	127.2-271.3	219.8	31.8	—	—	—	—
	Condition	5	1.1-1.3	1.2	0.0	4	1.3-1.5	1.4	0.1	—	—	—	—

Table 20.—(Cont.)

Locality	Factor	June				July				August			
		n	range	mean	se	*n*	range	mean	se	*n*	range	mean	se
Northern and Southern regions													
Unmarked													
Upper	Length	1	203	203.0	0.0	—	—	—	—	—	—	—	—
Chatham	Weight	1	105.0	105.0	0.0	—	—	—	—	—	—	—	—
Strait	Condition	1	1.3	1.3	0.0	—	—	—	—	—	—	—	—
Icy	Length	1	261	261.0	0.0	—	—	—	—	1	255	255.0	0.0
Strait	Weight	1	229.6	229.6	0.0	—	—	—	—	1	223.1	223.1	0.0
	Condition	1	1.3	1.3	0.0	—	—	—	—	1	1.3	1.3	0.0
Middle	Length	2	176-226	201.0	25.0	1	187	187.0	0.0	—	—	—	—
Clarence	Weight	2	62-118.5	90.3	28.3	1	76.7	76.7	0.0	—	—	—	—
Strait	Condition	2	1.0-1.1	1.1	0.1	1	1.2	1.2	0.0	—	—	—	—
Lower	Length	3	164-241	190.3	25.3	—	—	—	—	—	—	—	—
Clarence	Weight	3	51.2-130.3	79.3	25.5	—	—	—	—	—	—	—	—
Strait	Condition	3	0.9-1.2	1.1	0.1	—	—	—	—	—	—	—	—
Total	Length	7	164-261	205.3	14.6	1	187	187.0	0.0	1	255	255.0	0.0
	Weight	7	51.2-229.6	107.6	23.6	1	76.7	76.7	0	1	223.1	223.1	0.0
	Condition	7	0.9-1.3	1.1	0.0	1	1.2	1.2	0.0	1	1.3	1.3	0.0

Table 21.—Number of potential predators of juvenile salmon examined at sea, captured by rope trawl in the marine waters of the northern and southern regions of southeastern Alaska, June–August 2005.

Predator species	Number examined	Number empty	Percent feeding	Number with salmon	Percent feeders with salmon
			Salmonids		
Pink salmon[3]	31	3	90.3	0	0
Chum salmon[3]	4	2	50.0	0	0
Sockeye salmon[3]	2	1	50.0	0	0
Coho salmon[3]	2	0	100.0	0	0
Chinook salmon[2]	12	0	100.0	0	0
			Non-salmonids		
Spiny dogfish[3]	9	1	88.9	1	12.5
Starry flounder[3]	1	0	100.0	0	0.0
Walleye pollock[2]	2	0	100.0	0	0.0
Total	63	7	88.9	1	1.8

[1]Juvenile [2]Immature [3]Adult

Table 22.—Number (*n*), size (FL, mm and weight, g), and stomach fullness (percent volume) by range, mean, and standard deviation (sd) of 63 potential predators of juvenile salmon captured at transects in marine strait habitats of the northern and southern regions of southeastern Alaska, June–August, 2005. See Table 21 and Figure 15 for additional feeding and diet summaries.

		Fork length (mm)			Weight (g)			Stomach fullness (% volume)		
Species	*n*	Range	Mean	Sd	Range	Mean	Sd	Range	Mean	Sd
Northern region										
June										
Chinook salmon[2]	4	420-848	679.0	202.9	1000-8500	4887.5	3464.2	0-100	51.3	44.8
Pink salmon[3]	5	455-582	541.4	49.7	1050-2300	1810.0	506.7	50-100	77.0	18.2
Sockeye salmon[3]	1	607	607.0	—	2650	2650.0	—	100	100.0	—
July										
Chinook salmon[2]	3	305-655	456.0	179.9	400-3400	1550.0	1617.9	25-100	68.3	38.8
Chum salmon[3]	2	580-592	586.0	8.5	2050-2400	2225.0	247.5	10-50	30.0	28.3
Coho salmon[3]	1	608	608.0	—	2700	2700.0	—	1	1.0	—
Pink salmon[3]	15	450-620	523.6	41.5	1100-2750	1624.0	454.3	1	21.3	25.2
Sockeye salmon[3]	1	647	647.0	—	3150	3150.0	—	0	0.0	—
Walleye pollock[2]	2	295-318	306.5	16.3	200-320	260.0	84.9	1	50.5	70.0
August										
Chinook salmon[2]	1	530	530.0	—	2000	2000.0	—	1	1.0	—
Chum salmon[3]	1	630	630.0	—	3300	3300.0	—	1	1.0	—
Pink salmon[3]	3	470-490	480.0	10.0	1000-1400	1166.7	208.2	75	91.7	14.4

Table 22.—(Cont.)

Species	*n*	Fork length (mm)			Weight (g)			Stomach fullness (% volume)		
		Range	Mean	Sd	Range	Mean	Sd	Range	Mean	Sd
Southern region										
June										
Chinook salmon[2]	3	342-861	544.7	277.5	590-6800	2813.3	3460.2	0-50	25.0	25.0
Coho salmon[3]	1	643	643.0	—	3200	3200.0	—	100	100.0	—
Spiny dogfish[3]	1	730	730.0	—	2660	2660.0	—	100	100.0	—
Starry flounder[3]	1	432	432.0	—	1050	1050.0	—	100	100.0	—
July										
Chinook salmon[2]	1	635	635.0	—	3150	3150.0	—	100	100.0	—
Chum salmon[3]	1	702	702.0	—	3950	3950.0	—	1	1.0	—
Pink salmon[3]	8	465-555	499.5	34.1	1200-1750	1431.3	226.7	0-80	26.9	32.9
Spiny dogfish[3]	8	490-745	609.0	76.9	700	1293.8	488.0	0	47.1	46.8

[1]Juvenile [2]Immature [3]Adult

Table 23.—Subsamples of wild and hatchery juvenile chum salmon stocks and juvenile pink salmon collected in the northern region of the marine waters of southeastern Alaska in June and July, 2005, and selected for Northern Fund process studies of diet (D) and energy content (E). Only hauls with chum salmon catches that were analyzed for otolith thermal marks are included; — denotes no sample available, x denotes sample not selected for processing. Abbreviations: ER = Early Release, LL = Late Large. See text for protocols.

		DIPAC												NSRAA						Unmarked			
		Amalga Harbor				Boat Harbor		Gastineau				Lime-stone		Kasnyku				Takatz		Chum		Pink	
		ER		LL				ER		LL				ER		LL							
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
Northern region																							
June																							
Icy Strait transect																							
ISA	9040	—	—	—	—	—	—	—	—	—	—	—	—	x	x	x	—	—	x	—	—	—	—
ISA	9048	x	1	—	—	—	x	2	—	1	x	—	—	x	x	x	—	x	x	x	x	—	x
ISA	9052	3	5	1	—	5	2	—	2	2	x	2	2	x	x	4	—	x	x	x	x	x	x
ISB	9049	7	4	—	2	6	4	9	3	3	7	—	2	10	7	2	1	10	10	10	10	10	10
ISC	9042	—	x	—	3	—	x	—	—	—	x	—	1	—	—	—	—	—	x	—	x	—	—
ISC	9050	x	x	—	1	x	2	—	2	3	3	2	1	x	x	1	1	x	x	x	x	x	x
ISD	9043	x	x	1	1	x	x	6	—	x	x	—	x	10	7	x	—	9	10	10	9	x	x
Upper Chatham Strait transect																							
UCA	9039	—	x	—	1	—	—	—	—	—	—	—	x	—	2	—	—	—	x	—	x	—	x
UCA	9047	—	—	—	—	—	—	—	x	—	—	—	—	—	2	—	—	—	—	—	—	—	x
UCB	9038	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	x	—	x
UCB	9046	x	—	1	—	x	—	x	—	x	—	3	—	4	—	x	—	x	—	x	—	x	—
UCC	9037	—	x	—	x	—	2	—	x	—	x	—	—	—	2	—	—	—	4	—	x	—	x
UCC	9045	x	—	—	2	3	1	6	4	10	5	3	3	8	3	3	—	10	5	8	7	8	—

Table 23.—(Cont.)

		DIPAC												NSRAA						Unmarked			
		Amalga Harbor				Boat Harbor		Gastineau				Lime-stone		Kasnyku				Takatz		Chum		Pink	
		ER		LL				ER		LL				ER		LL							
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
UCD	9036	—	x	—	x	—	—	—	—	—	—	—	—	—	1	—	—	—	x	—	x	—	x
UCD	9044	x	x	1	—	3	2	—	x	x	5	—	1	—	—	—	—	x	x	10	10	x	10
	Total	10	10	4	10	17	13	23	11	19	20	10	10	32	24	10	2	29	29	38	36	18	20
July Icy Strait transect																							
ISA	9093	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	x	—	x
ISA	9100	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ISB	9092	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	2	—	x	—	x
ISC	9088	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	x	—	x
ISC	9091	—	—	—	—	—	—	—	—	—	1	—	—	—	3	—	—	—	1	—	x	—	x
ISD	9089	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	1	—	x	—	x
ISD	9090	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	10	—	8
ISD	9103	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	x	—	7	—
ISD	9104	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	5	—
Upper Chatham Strait transect																							
UCB	9084	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	x
UCC	9083	—	—	—	—	—	—	—	—	1	—	—	—	4	—	1	—	7	—	10	—	10	10
UCC	9096	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	x

Table 23.—(Cont.)

		DIPAC												NSRAA						Unmarked			
		Amalga Harbor				Boat Harbor		Gastineau				Lime-stone		Kasnyku				Takatz		Chum		Pink	
		ER		LL				ER		LL				ER		LL							
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
UCD	9082	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	9	—	x
UCD	9095	—	—	—	—	—	—	—	—	—	—	—	—	4	—	1	—	1	—	x	—	x	—
	Total	0	0	0	0	0	0	0	2	1	2	0	1	11	12	2	1	9	7	10	20	22	18

Table 24.—Subsamples of wild and hatchery juvenile chum salmon stocks and juvenile pink salmon collected in the southern region of the marine waters of southeastern Alaska in June and July, 2005, and selected for Northern Fund process studies of diet (D) and energy content (E). Only hauls with chum salmon catches that were analyzed for otolith thermal marks are included; — denotes no sample available, x denotes sample not selected for processing. See text for protocols.

		SSRAA												Unmarked			
		Anita Bay		Kendrick Bay		Nakat fall		Nakat summer		Neets fall		Neets summer		Chum		Pink	
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
Southern region																	
June																	
Lower Clarence Strait transect																	
LCA	9022	—	4	—	1	—	—	—	—	—	x	—	x	—	10	—	x
LCA	9027	—	—	—	—	—	—	—	—	x	—	—	—	x	—	x	—
LCA	9034	1	—	2	—	—	—	—	—	x	—	x	x	x	—	x	—
LCB	9021	—	1	—	—	—	—	—	—	—	6	—	7	—	10	—	x
LCB	9028	—	—	—	—	—	—	—	—	10	x	7	x	10	—	x	x
LCC	9020	—	—	—	2	—	1	—	—	—	5	—	8	—	x	—	x
LCC	9029	—	—	2	—	1	—	—	—	10	—	9	x	10	—	10	10
LCC	9032	—	1	—	—	—	—	—	—	—	—	—	x	—	x	—	—
LCD	9019	—	—	—	—	—	—	—	—	—	x	—	x	—	8	—	x
LCD	9030	1	—	—	—	2	—	—	—	x	—	1	—	x	—	x	—
LCD	9031	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Middle Clarence Strait transect																	
MCA	9018	—	—	—	1	—	—	—	—	—	x	—	x	—	10	x	x
MCA	9026	4	—	2	—	1	—	—	—	10	10	10	6	10	5	x	x
MCB	9017	3	2	1	1	2	—	—	—	x	x	x	x	x	x	x	x

Table 24.—(Cont.)

		SSRAA												Unmarked			
		Anita Bay		Kendrick Bay		Nakat fall		Nakat summer		Neets fall		Neets summer		Chum		Pink	
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
MCB	9025	x	—	1	—	—	—	—	—	x	x	x	x	x	x	x	x
MCC	9016	3	6	4	2	4	—	—	—	10	x	10	x	10	10	10	10
MCC	9024	—	—	—	1	—	—	—	1	—	x	—	x	—	x	—	x
MCD	9015	—	4	—	5	—	1	—	—	—	x	—	10	—	10	—	x
MCD	9023	—	—	—	—	—	—	—	—	—	x	—	x	—	x	—	x
	Total	12	18	12	13	10	2	0	1	40	21	37	31	40	64	20	20
July																	
Lower Clarence Strait transect																	
LCA	9056	1	1	2	—	—	—	x	—	10	10	7	6	10	8	10	10
LCA	9064	—	—	—	—	—	—	—	—	—	—	—	x	—	x	—	x
LCA	9072	—	—	—	—	—	—	—	—	—	x	—	—	—	x	—	x
LCB	9057	—	—	—	1	—	—	—	—	—	—	—	—	—	x	—	x
LCB	9065	—	—	—	—	—	—	—	—	—	x	—	x	—	x	—	x
LCB	9071	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—
LCC	9058	—	—	—	—	—	—	—	—	—	x	—	1	—	x	—	—
LCC	9066	—	—	—	—	—	—	—	—	—	—	—	x	—	x	—	x
LCC	9068	—	1	—	2	—	—	—	—	—	—	—	x	—	x	—	—
LCD	9059	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
Middle Clarence Strait transect																	
MCA	9063	—	2	—	—	—	—	—	—	—	x	—	5	—	8	—	3

Table 24.—(Cont.)

		SSRAA												Unmarked			
		Anita Bay		Kendrick Bay		Nakat fall		Nakat summer		Neets fall		Neets summer		Chum		Pink	
Station	Haul	D	E	D	E	D	E	D	E	D	E	D	E	D	E	D	E
MCA	9077	—	—	—	—	—	—	—	—	x	—	2	—	5	—	7	—
MCC	9061	—	—	—	—	—	—	—	—	—	x	—	—	—	6	—	2
MCC	9079	—	—	—	—	—	—	—	—	x	—	1	—	1	—	x	—
MCD	9060	—	—	—	1	—	—	—	—	—	—	—	—	—	x	—	—
	Total	1	4	2	4	0	0	0	0	10	10	10	12	16	24	17	15

Table 25.—Correlation coefficient of CPUE of juvenile pink salmon and associated biophysical parameters in year *y* for 1997-2004 with adult pink salmon harvest in southeastern Alaska in year *y* + 1.

Parameter	*r*	*P*-value
Peak CPUE	0.93	0.001
June/July average CPUE (JJ-Avg CPUE)	0.81	0.015
June/July/August average CPUE (JJA-Avg CPUE)	0.87	0.005
May 3-m water temperature	0.33	0.427
July 3-m water temperature	0.33	0.431
July 2-m salinity	-0.23	0.582
May/June average zooplankton total water column	0.10	0.816
May/June average zooplankton 20-m	-0.05	0.899
June-July pink salmon increase in average size	0.50	0.206
Pink salmon size July 22	0.41	0.319
Releases of hatchery chum fry	0.06	0.894

Table 26.—Harvests and predicted harvests for southeastern Alaska pink salmon returning in 2004, 2005, and 2006. Forecast models compared are SECM juvenile CPUE models and the ADFG exponential smoothing model (ADFG). Harvest numbers are in millions of fish.

Year/forecast model	Actual harvest	Forecast harvest	Forecast 80% CI	Deviation (%)
2004	45.3			
Peak CPUE		47.0	34.1-63.9[1]	3.8
JJ-Avg CPUE		40.9	18.7-63.1[1]	-9.7
ADFG[2]		50	24-76	10.4
2005	59.2[3]			
Peak CPUE		59.1	46.6-71.7[1]	-0.2
JJ-Avg CPUE		53.1	34.3-71.9[1]	-10.3
ADFG[4]		49	25-72	-17.2
2006	11.4[3]			
Peak CPUE (excludes Aug)		35.2	28.8-42.6	-67.6
JJ-Avg CPUE		40.9	35.7-44.9	-72.1
Peak CPUE (includes Aug)		54.4	45.6-61.8	-79.0
JJA-Avg CPUE		54.9	49.0-61.1	-79.2
ADFG[6]		52	29-74	-78.1

[1]Parametric prediction intervals for the regression model.
[2]Plotnick and Eggers (2004)
[3]ADFG (2006) preliminary data
[4]Eggers (2005)
[5]Bootstrap confidence intervals for the regression model.
[6]Eggers (2006)

Table 27.—Regression models relating juvenile catch per unit effort (CPUE) of pink salmon in year *y* to adult harvest in southeastern Alaska in year *y* +1. R^2 = coefficient of determination; *P* = statistical significance of model.

Model	Constant	Predictor	Adjusted R^2 (%)	*P*
Ln (Peak CPUE)	6.30	13.71	84.8	0.001
Ln (JJ-Avg CPUE)	19.43	13.16	60.0	0.015
Ln (JJA-Avg CPUE)	6.36	21.56	71.3	0.005

Table 28.—Annual harvests, total escapement index counts, and estimated total run index incorporating weighted escapement counts for southeastern Alaska pink salmon, 1998-2005, in millions of fish. The weighting factor was the average annual ratio of harvest to the escapement index count.

Year	Harvest[1]	Escapement index[2]	Ratio harvest/escapement	Weighted escapement	Total run index
1998	42.53	15.93	2.67	32.33	84.86
1999	77.77	30.46	2.55	80.91	158.68
2000	20.25	12.07	1.68	32.07	52.32
2001	67.05	19.20	3.49	51.01	118.06
2002	45.33	17.35	2.61	46.09	91.42
2003	52.52	21.30	2.47	56.57	109.09
2004	45.33	15.84	2.86	42.08	87.41
2005	59.17	20.26	2.92	53.82	112.99
Average			2.66		

[1]ADFG (2006)
[2]Personal communication, Steve Heinl, Alaska Department of Fish and Game

Table 29.—Predicted harvests in millions of fish for southeastern Alaska pink salmon in 2006 using juvenile catch per unit effort (CPUE) models with the dependent (predicted) variable either (1) an index of total run or (2) actual harvest. The predicted harvest from the total run forecast is estimated by assuming a 50% exploitation of the total run.

Model	Dependent variable index total run	Predicted harvest of index total run	Dependent variable actual harvest
Peak CPUE (excludes Aug)	70.9	35.5	35.2
JJ-Avg CPUE	82.1	41.1	40.9
Peak CPUE (includes Aug)	107.5	53.2	54.4
JJA-Avg CPUE	108.3	54.1	54.9

Appendix 1.—Catch and life history stage of salmonids captured in marine waters of the northern and southern regions of southeastern Alaska, June–August 2005.

			Juvenile					Immature and Adult				
Date	Haul #	Station	Pink	Chum	Sockeye	Coho	Chinook	Pink	Chum	Sockeye	Coho	Chinook
21-June	9015	MCD	76	43	12	4	—	—	—	—	—	—
21-June	9016	MCC	94	89	19	8	2	—	—	—	—	—
21-June	9017	MCB	353	86	19	7	—	—	—	—	—	—
21-June	9018	MCA	139	30	1	—	—	—	—	—	—	—
22-June	9019	LCD	46	10	—	1	1	—	—	—	—	1
22-June	9020	LCC	69	23	5	9	1	—	—	—	—	—
22-June	9021	LCB	105	26	3	29	—	—	—	—	—	—
22-June	9022	LCA	79	24	23	27	—	—	—	—	—	—
23-June	9023	MCD	17	9	6	14	—	—	—	—	—	1
23-June	9024	MCC	74	15	5	4	1	—	—	—	—	—
23-June	9025	MCB	216	82	10	10	1	—	—	—	—	—
23-June	9026	MCA	164	92	2	11	—	—	—	—	—	—
24-June	9027	LCA	6	11	—	9	—	—	—	—	—	—
24-June	9028	LCB	129	49	8	1	—	—	—	—	—	—
24-June	9029	LCC	57	47	18	5	—	—	—	—	—	—
24-June	9030	LCD	14	15	7	4	—	—	—	—	—	—
25-June	9031	LCD	—	1	—	12	—	—	—	—	1	—
25-June	9032	LCC	—	6	3	22	—	—	—	—	—	—
25-June	9033	LCB	—	—	3	1	—	—	—	—	—	—
25-June	9034	LCA	27	23	16	5	1	—	—	—	—	1
28-June	9036	UCD	2	8	4	9	1	—	—	—	—	—
28-June	9037	UCC	9	43	6	17	—	—	—	—	—	—
28-June	9038	UCB	2	3	2	34	—	—	—	—	—	—
28-June	9039	UCA	2	16	2	6	1	1	—	—	—	—
29-June	9040	ISA	—	1	—	—	—	—	—	—	—	—
29-June	9041	ISB	2	1	—	13	—	—	—	—	—	—

Appendix 1.—(Cont.)

Date	Haul#	Station	Juvenile					Immature and Adult				
			Pink	Chum	Sockeye	Coho	Chinook	Pink	Chum	Sockeye	Coho	Chinook
29-June	9042	ISC	—	14	2	24	2	—	—	—	—	2
29-June	9043	ISD	39	294	21	16	1	—	—	1	—	—
30-June	9044	UCD	60	57	20	20	1	—	—	—	—	2
30-June	9045	UCC	8	112	11	20	2	—	—	—	—	—
30-June	9046	UCB	7	48	9	29	—	—	—	—	—	—
30-June	9047	UCA	1	1	—	6	—	—	—	—	—	—
1-July	9048	ISA	2	20	4	5	—	—	—	—	—	—
1-July	9049	ISB	97	143	5	16	—	—	—	—	—	—
1-July	9050	ISC	27	65	4	2	—	2	—	—	—	—
1-July	9051	ISD	157	43	4	3	1	—	—	—	—	—
2-July	9052	ISA	24	83	4	2	—	1	—	—	—	—
2-July	9053	ISB	56	671	53	11	—	—	—	—	—	—
2-July	9054	ISC	—	1	—	1	—	—	—	—	—	—
2-July	9055	ISD	—	26	3	30	—	1	—	—	—	—
21-July	9056	LCA	67	74	—	5	—	—	—	—	—	—
21-July	9057	LCB	1	2	1	4	1	—	—	—	—	—
21-July	9058	LCC	—	4	2	—	—	2	—	—	—	—
21-July	9059	LCD	—	2	1	7	—	1	1	—	—	—
22-July	9060	MCD	—	2	—	5	—	1	—	—	—	—
22-July	9061	MCC	2	8	4	10	—	2	—	—	—	—
22-July	9062	MCB	—	—	—	—	—	—	—	—	—	—
22-July	9063	MCA	3	19	4	1	—	—	—	—	—	—
23-July	9064	LCA	1	5	1	—	—	—	—	—	—	—
23-July	9065	LCB	2	10	4	—	—	—	—	—	—	—
23-July	9066	LCC	1	3	—	4	—	2	—	—	—	—
23-July	9067	LCD	—	—	—	3	—	—	—	—	—	—
23-July	9068	LCC	—	6	—	—	—	—	—	—	—	—

Appendix 1.—(Cont.)

			Juvenile					Immature and Adult				
Date	Haul#	Station	Pink	Chum	Sockeye	Coho	Chinook	Pink	Chum	Sockeye	Coho	Chinook
24-July	9069	LCD	—	—	—	—	—	—	—	—	—	—
24-July	9070	LCC	—	—	—	—	—	—	—	—	—	—
24-July	9071	LCB	—	2	—	2	—	—	—	—	—	—
24-July	9072	LCA	1	2	1	—	—	—	—	—	—	—
25-July	9077	MCA	7	11	1	—	—	—	—	—	—	1
25-July	9078	MCB	—	—	—	6	1	—	—	—	—	—
25-July	9079	MCC	1	3	—	2	—	—	—	—	—	—
25-July	9080	MCD	—	—	—	—	—	—	—	—	—	—
27-July	9082	UCD	9	10	4	16	1	3	—	—	—	—
27-July	9083	UCC	35	30	6	13	—	—	—	—	—	—
27-July	9084	UCB	3	3	1	—	—	—	—	—	—	—
27-July	9085	UCA	—	—	—	5	—	4	—	—	—	—
28-July	9086	ISA	2	—	—	—	—	—	—	—	—	—
28-July	9087	ISB	—	—	—	—	—	—	—	—	—	—
28-July	9088	ISC	14	4	—	2	—	—	—	—	—	—
28-July	9089	ISD	1	14	1	2	1	—	—	—	—	—
29-July	9090	ISD	8	16	3	3	1	—	—	—	—	—
29-July	9091	ISC	4	10	1	2	—	1	1	1	—	—
29-July	9092	ISB	2	6	1	—	—	4	1	—	—	—
29-July	9093	ISA	16	2	1	6	1	—	—	—	—	1
29-July	9094	ISD	—	—	1	3	—	—	—	—	—	—
30-July	9095	UCD	10	11	4	5	—	2	—	—	—	—
30-July	9096	UCC	1	1	—	11	—	—	—	—	—	—
30-July	9097	UCB	—	—	—	13	—	—	—	—	—	—
30-July	9098	UCA	—	—	—	—	—	—	—	—	—	—
30-July	9099	UCD	—	—	—	9	—	1	—	—	—	1
31-July	9100	ISA	—	1	1	—	2	—	—	—	1	—

Appendix 1.—(Cont.)

			Juvenile					Immature and Adult				
Date	Haul#	Station	Pink	Chum	Sockeye	Coho	Chinook	Pink	Chum	Sockeye	Coho	Chinook
31-July	9101	ISB	1	—	—	3	—	—	—	—	—	—
31-July	9102	ISC	1	—	—	2	—	—	—	—	—	—
31-July	9103	ISD	7	4	—	6	—	—	—	—	—	1
31-July	9104	ISD	5	1	1	5	—	—	—	—	—	—
24-August	9106	UCA	1	—	—	7	—	—	—	—	—	1
24-August	9107	UCB	176	15	9	6	—	—	—	—	—	—
24-August	9108	UCC	79	20	1	2	—	—	1	—	—	—
24-August	9109	UCD	20	6	—	4	—	3	—	—	—	—
25-August	9110	ISA	34	7	1	6	—	—	—	—	—	—
25-August	9111	ISB	101	20	—	12	—	—	—	—	—	—
25-August	9112	ISC	78	24	4	6	1	—	—	—	—	—
25-August	9113	ISD	8	5	—	2	—	—	—	—	—	—

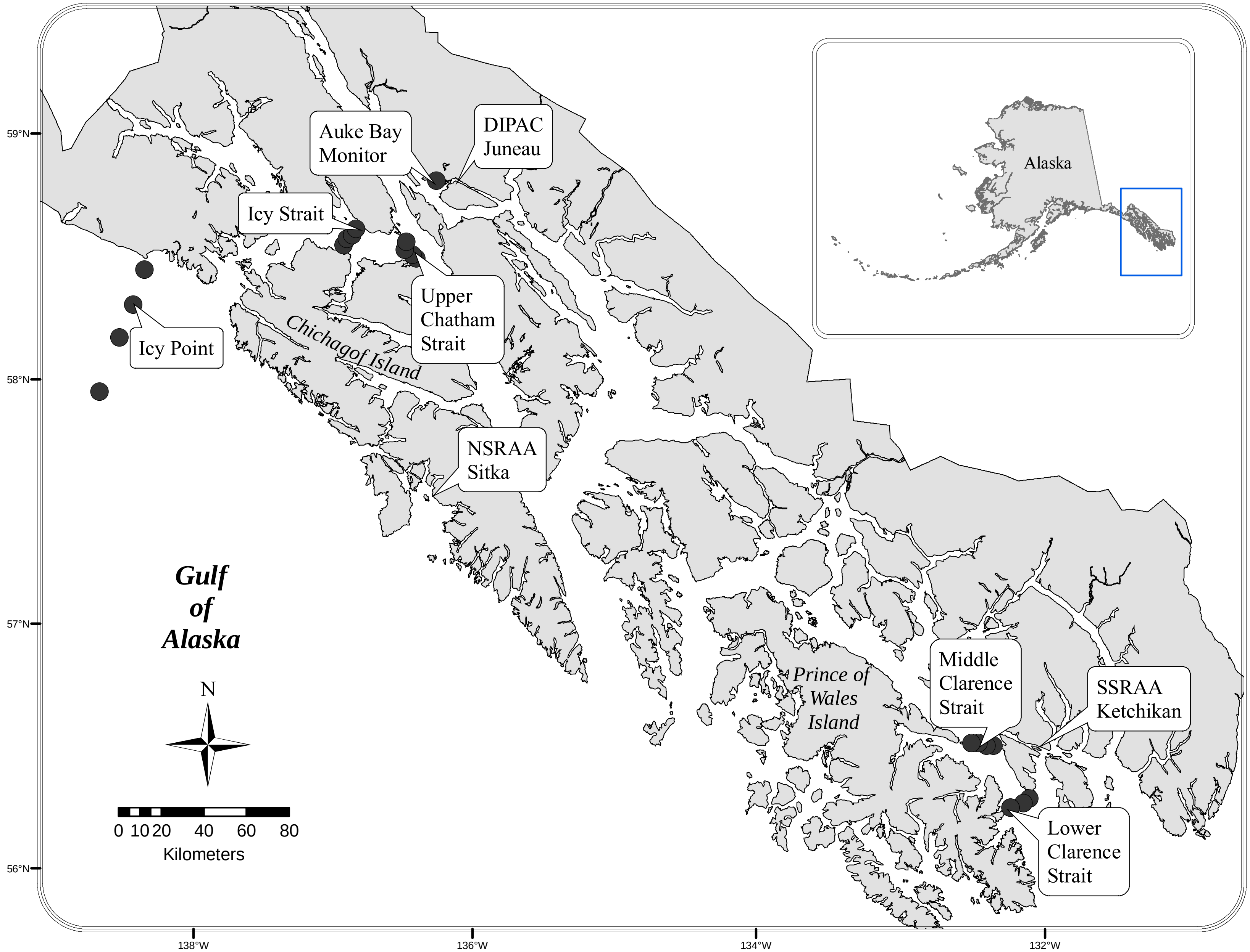

Figure 1.—Stations sampled in marine waters of the northern and southern regions of southeastern Alaska, May–August 2005.

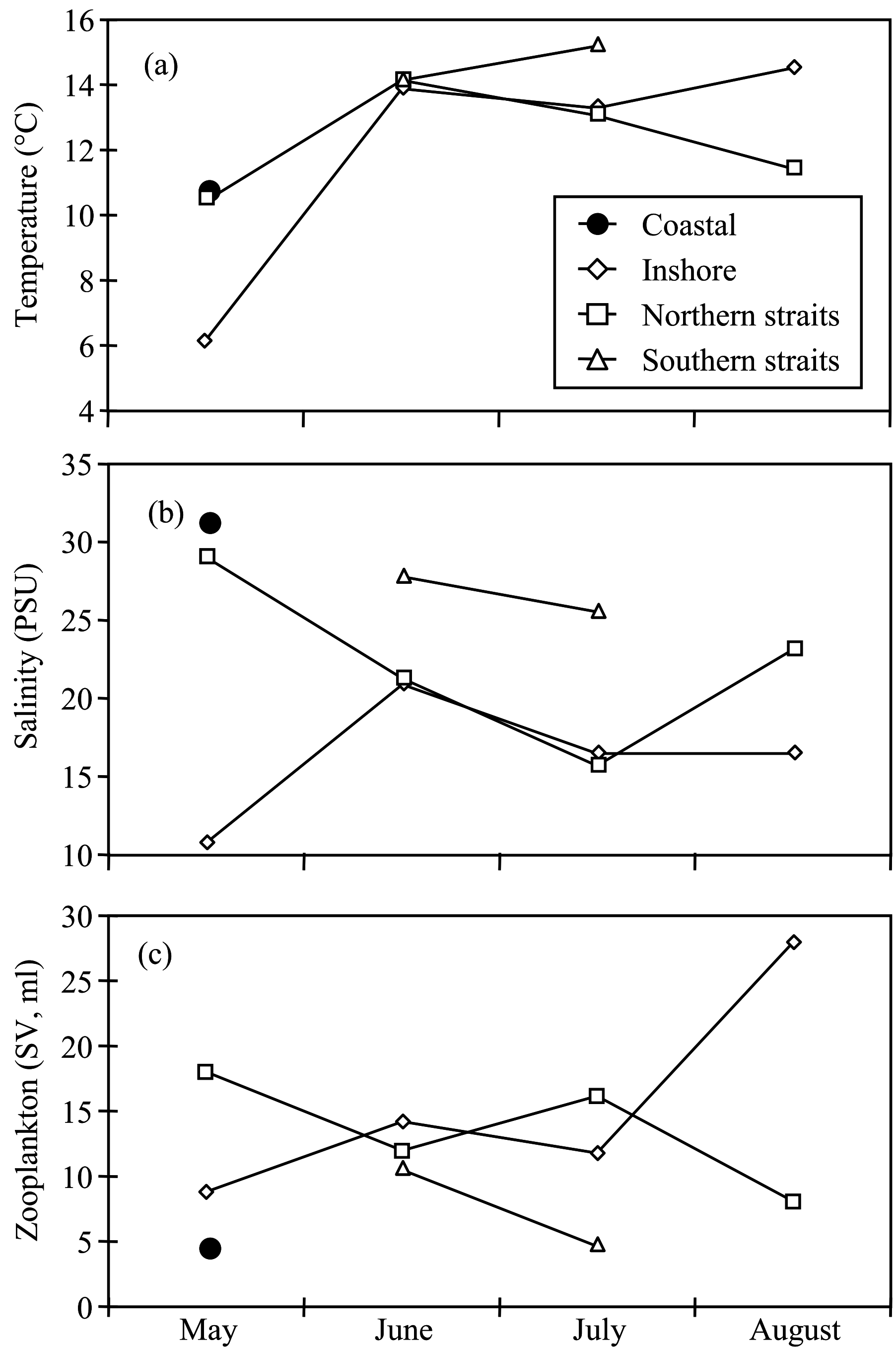

Figure 2.—Monthly mean surface 3-m temperature (°C, a), salinity (PSU, b), and 20-m zooplankton settled volumes from vertical NORPAC hauls (ml, c) in inshore, strait, and coastal marine habitats of the northern region and strait habitats of the southern region of southeastern Alaska, May–August 2005. Zooplankton standing stock (ml · m^{-3}) can be computed by dividing by water volume filtered, a factor of 3.9 m^3 for these samples. The southern region straits are represented by Lower and Middle Clarence Straits and the northern region straits are represented by Icy and Upper Chatham Straits.

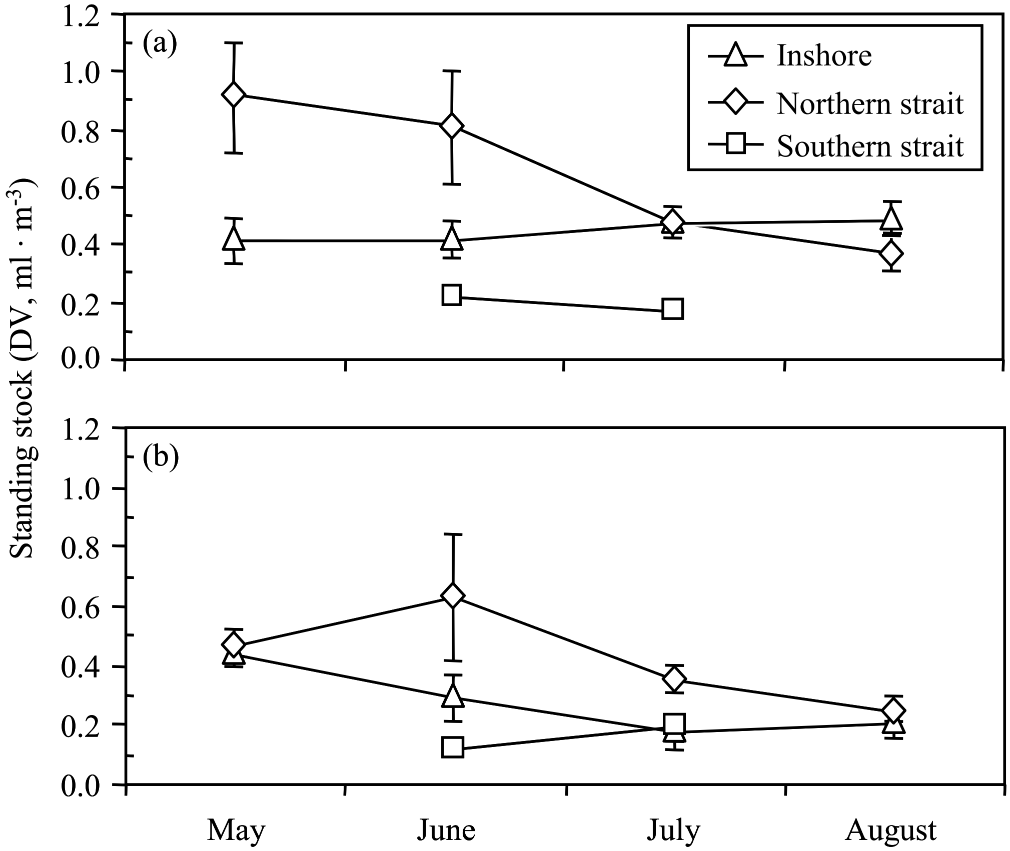

Figure 3.— Monthly zooplankton standing stock (mean ml · m^{-3}, ± 1 standard error) from 333-µm (a) and 505-µm (b) mesh, double oblique bongo net samples hauled from ≤200m depths at localities in southeastern Alaska, May-August 2005. The southern region strait is represented by Lower Clarence Strait and the northern region strait is represented by Icy Strait, Inshore is represented by Auke Bay Monitor.

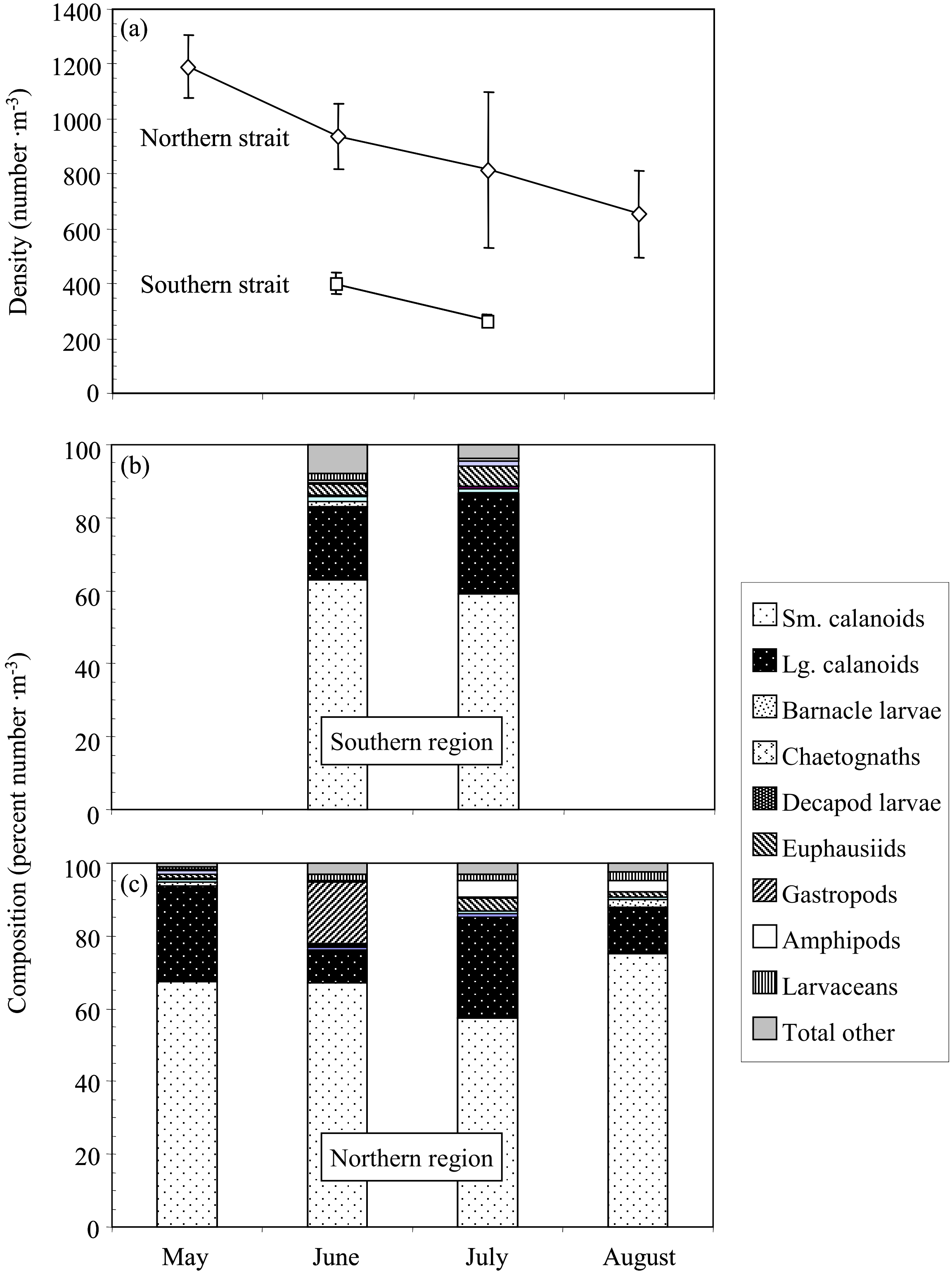

Figure 4.— Monthly zooplankton density (mean total number · m^{-3}, ± 1 standard error; (a)) and zooplankton taxonomic composition (mean percent number · m^{-3}) at strait habitats in the southern (b) and northern (c) regions of southeastern Alaska, May-August 2005, from 333-µm mesh, double oblique bongo net samples hauled from ≤200m depths. The southern region is represented by Lower Clarence Strait and the northern region is represented by Icy Strait.

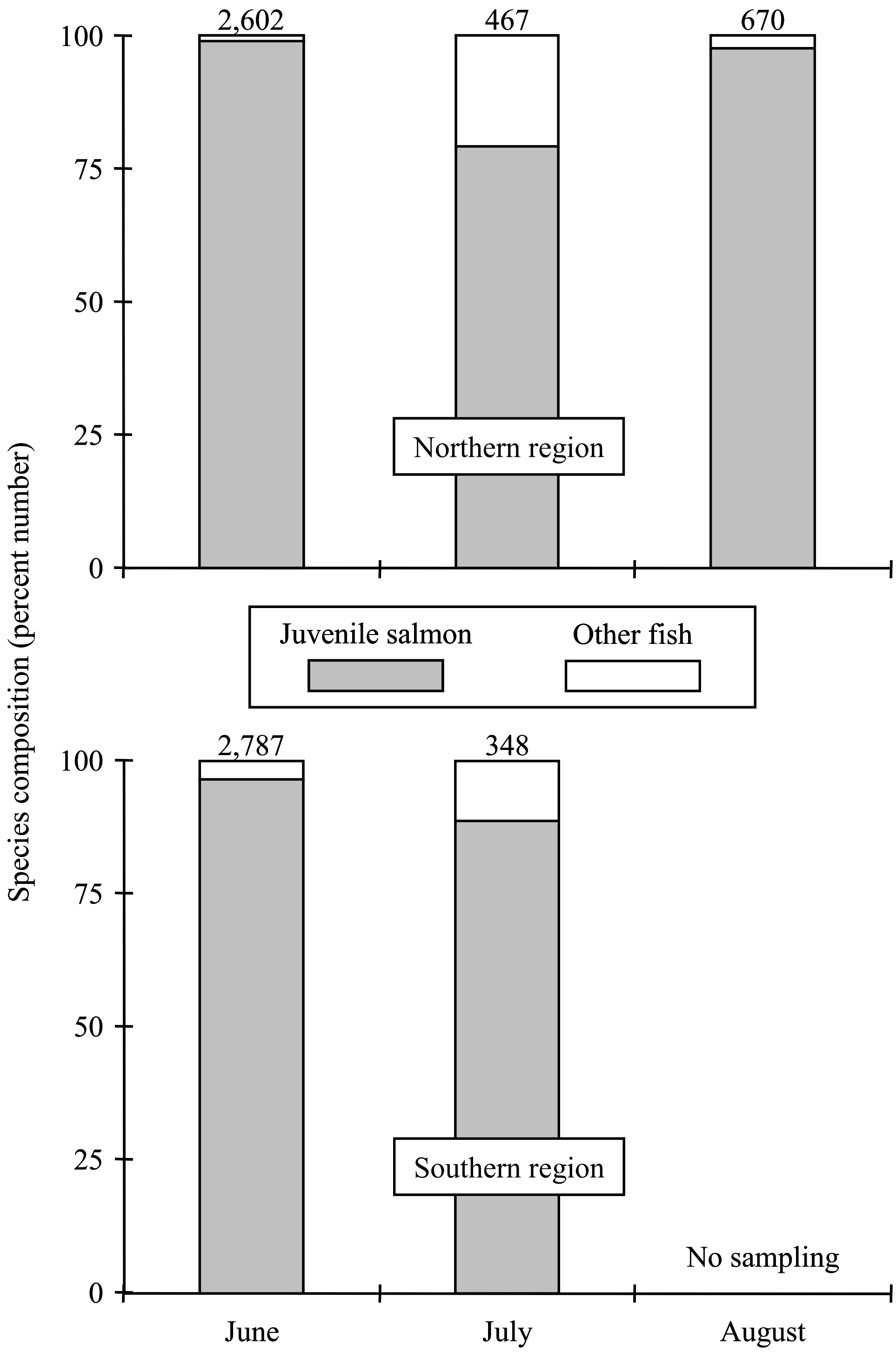

Figure 5.—Fish composition (percent number) from rope trawl catches in marine strait habitats of the northern and southern regions of southeastern Alaska, June–August 2005. Number of fish is indicated above each bar.

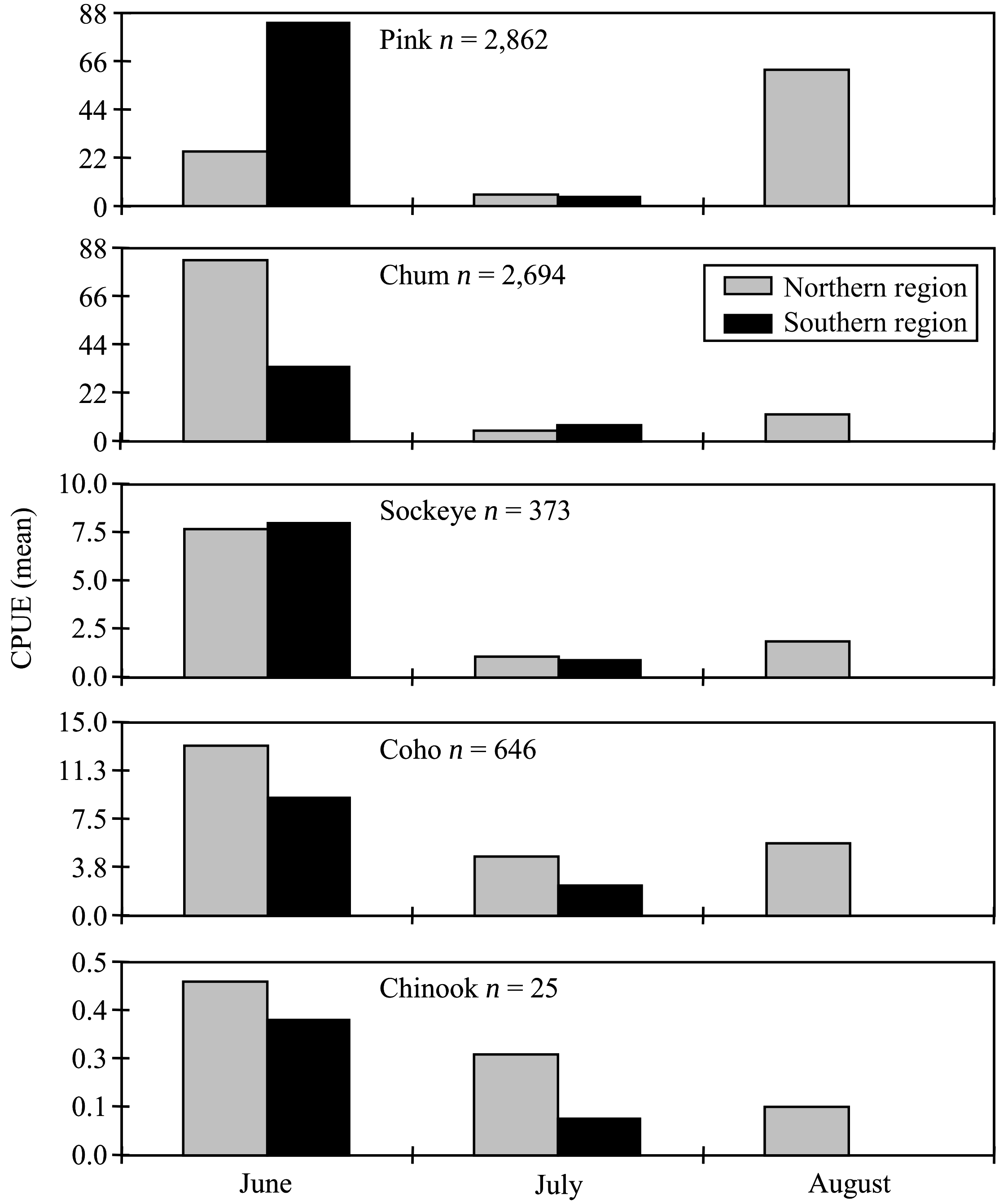

Figure 6.—Mean catch per rope trawl haul (CPUE) of juvenile salmon in marine strait habitats of the northern and southern region of southeastern Alaska, June–August, 2005. Total catch is indicated for each species.

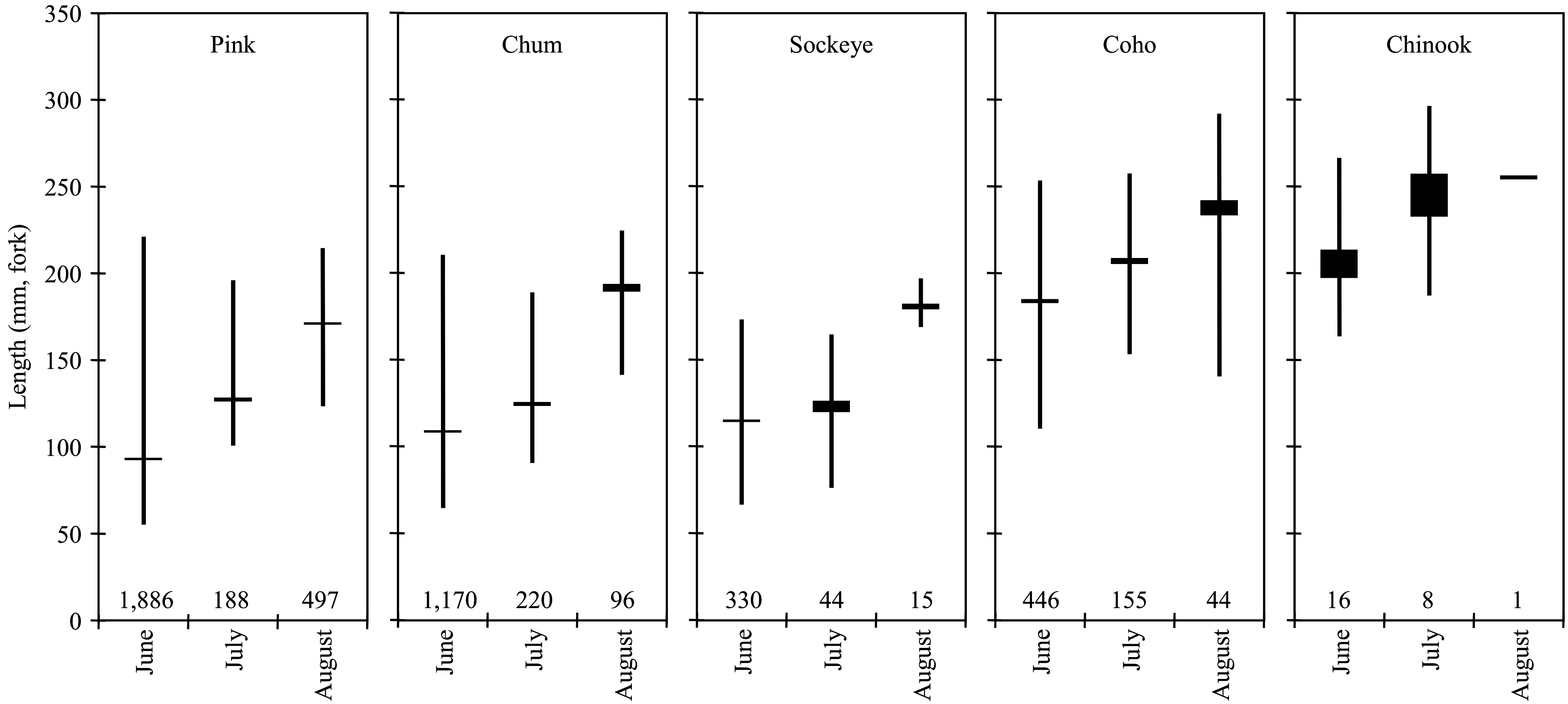

Figure 7.—Length (mm, fork) of juvenile salmon captured in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length of vertical bars is the fish size range for each sample, and the boxes within the size range represent mean fork length ±1 standard error. Sample sizes are shown for each month.

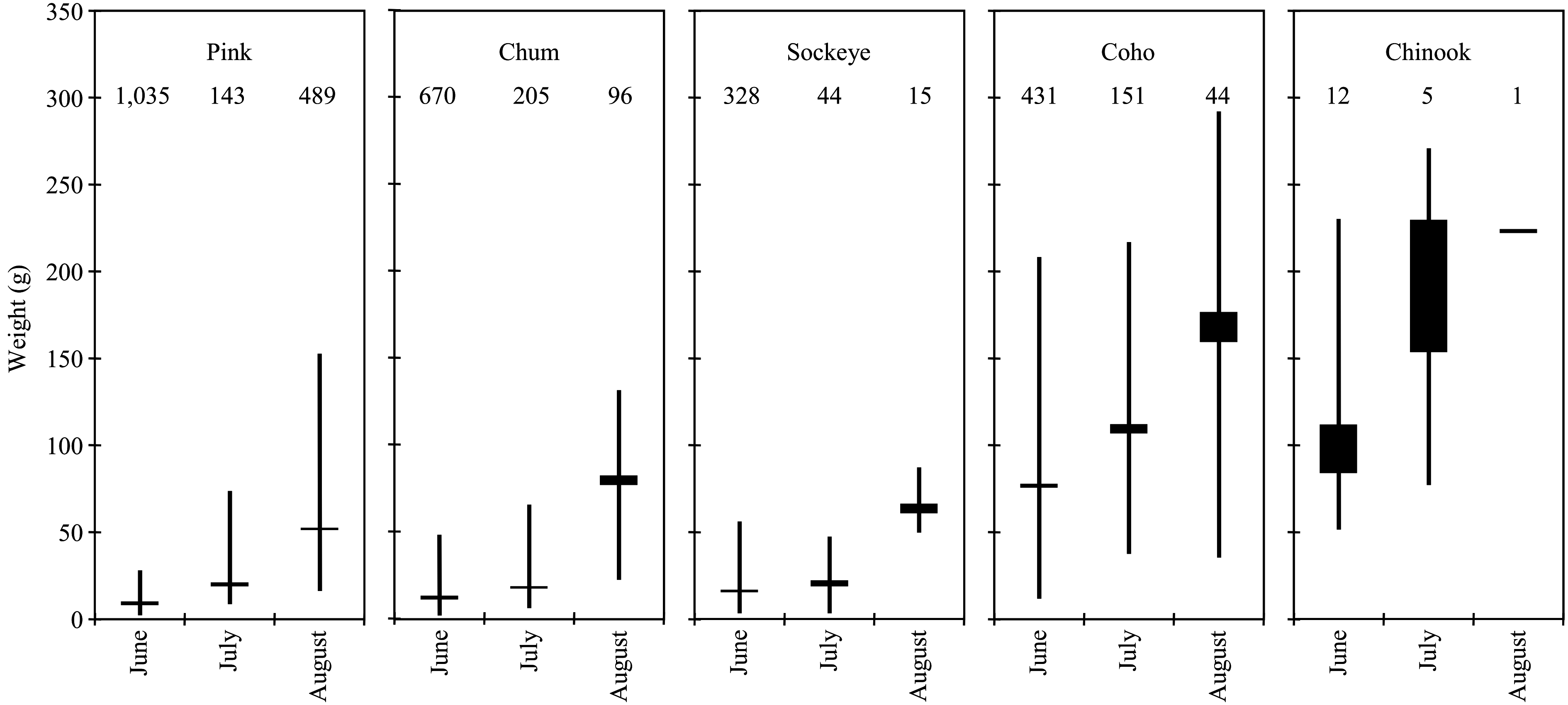

Figure 8.—Weight (g) of juvenile salmon captured in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length of vertical bars is the fish size range for each sample, and the boxes within the size range represent mean weight ±1 standard error. Sample sizes are shown for each month.

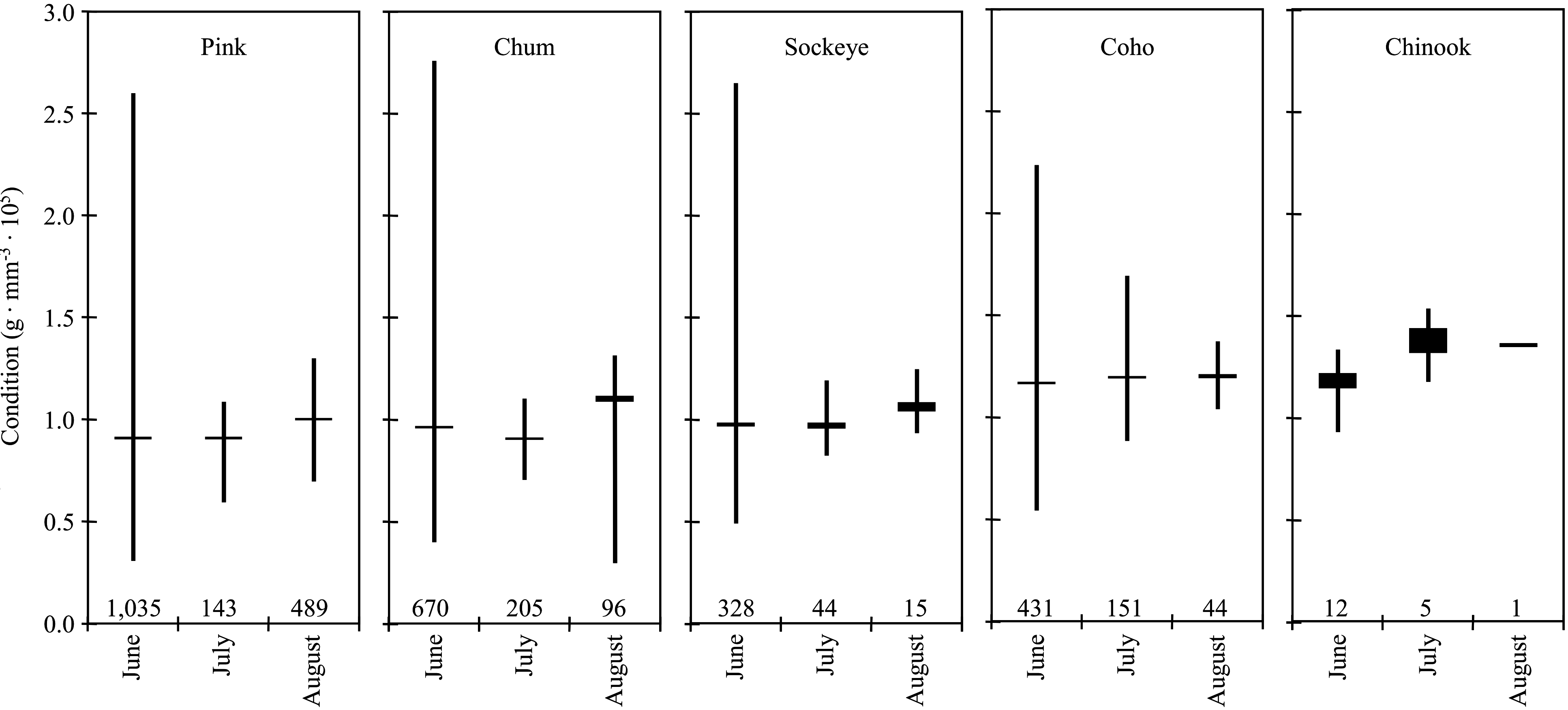

Figure 9.—Fulton's condition ($g \cdot mm^{-3} \cdot 10^5$) of juvenile salmon captured in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Length of vertical bars is the range in condition values for each sample, and the boxes within the range represent mean ±1 standard error. Sample sizes are shown for each month.

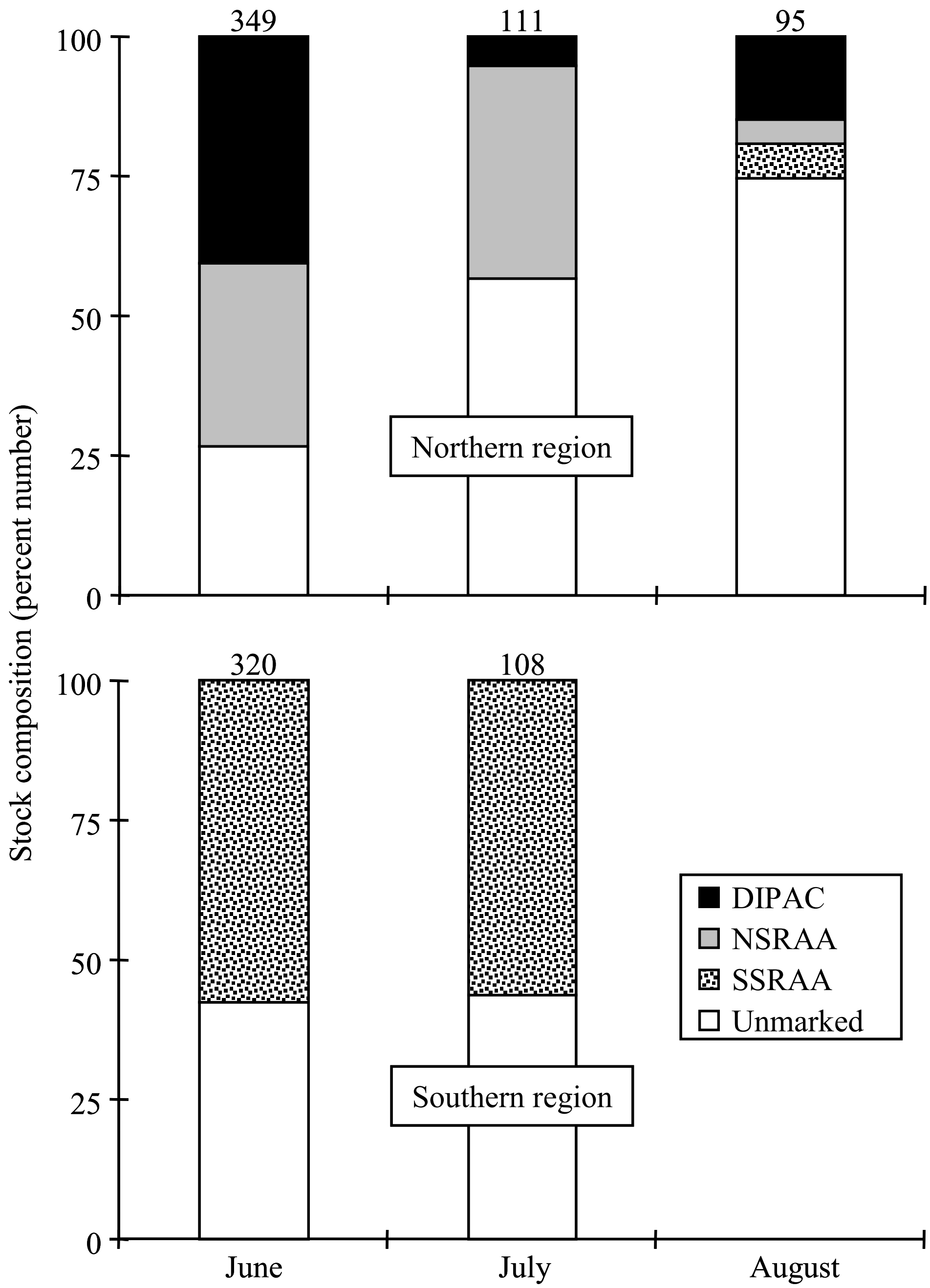

Figure 10.—Monthly stock composition (percent number) of juvenile chum salmon based on otolith thermal marks in marine strait habitats of the northern and southern regions of southeastern Alaska, June–August 2005. Number of salmon sampled per month and region is indicated above each bar.

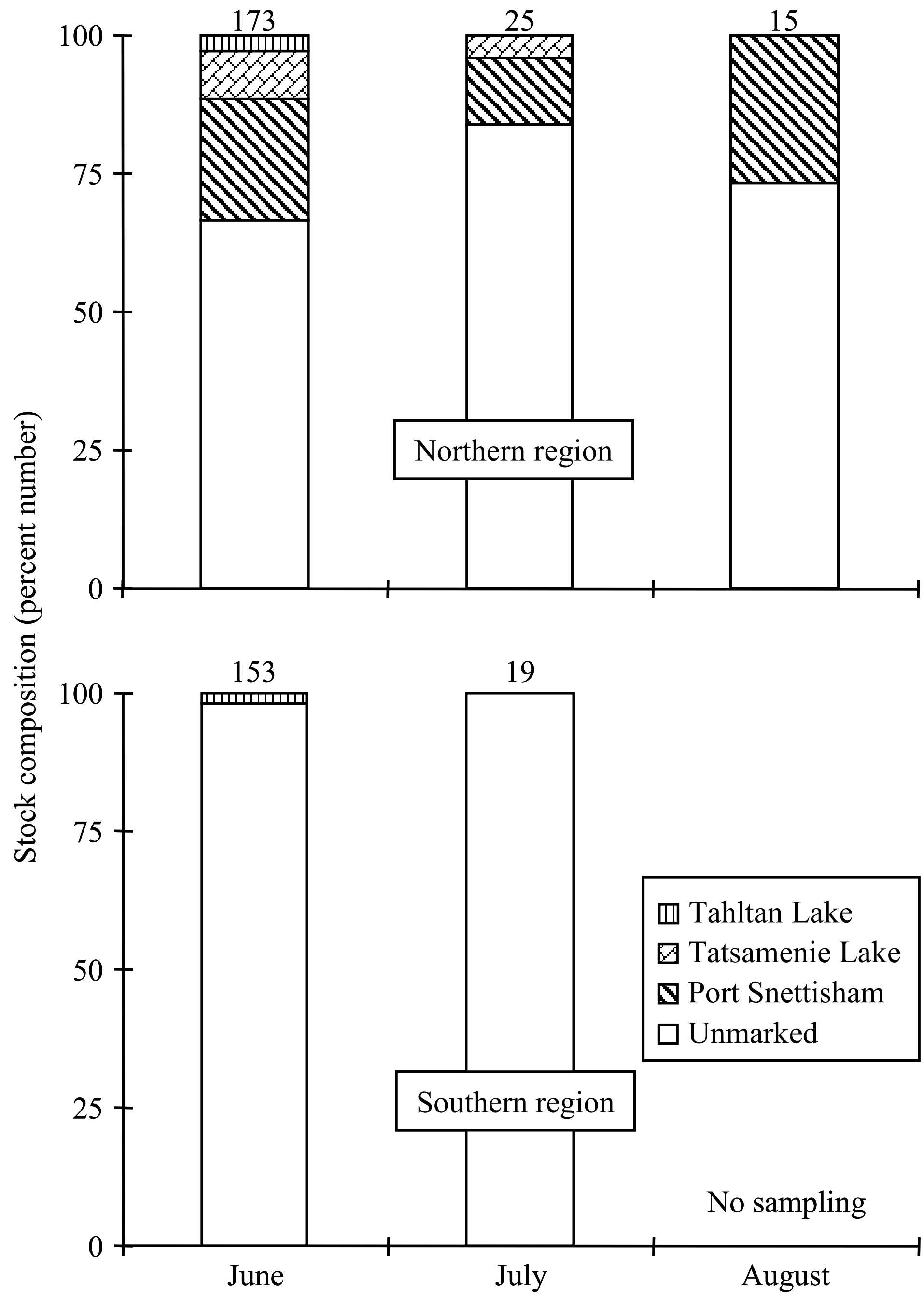

Figure 11.—Monthly stock composition (percent number) of juvenile sockeye salmon based on otolith thermal marks in marine strait habitats of the northern and southern regions of southeastern Alaska, June–August 2005. Number of salmon sampled per month and region is indicated above each bar.

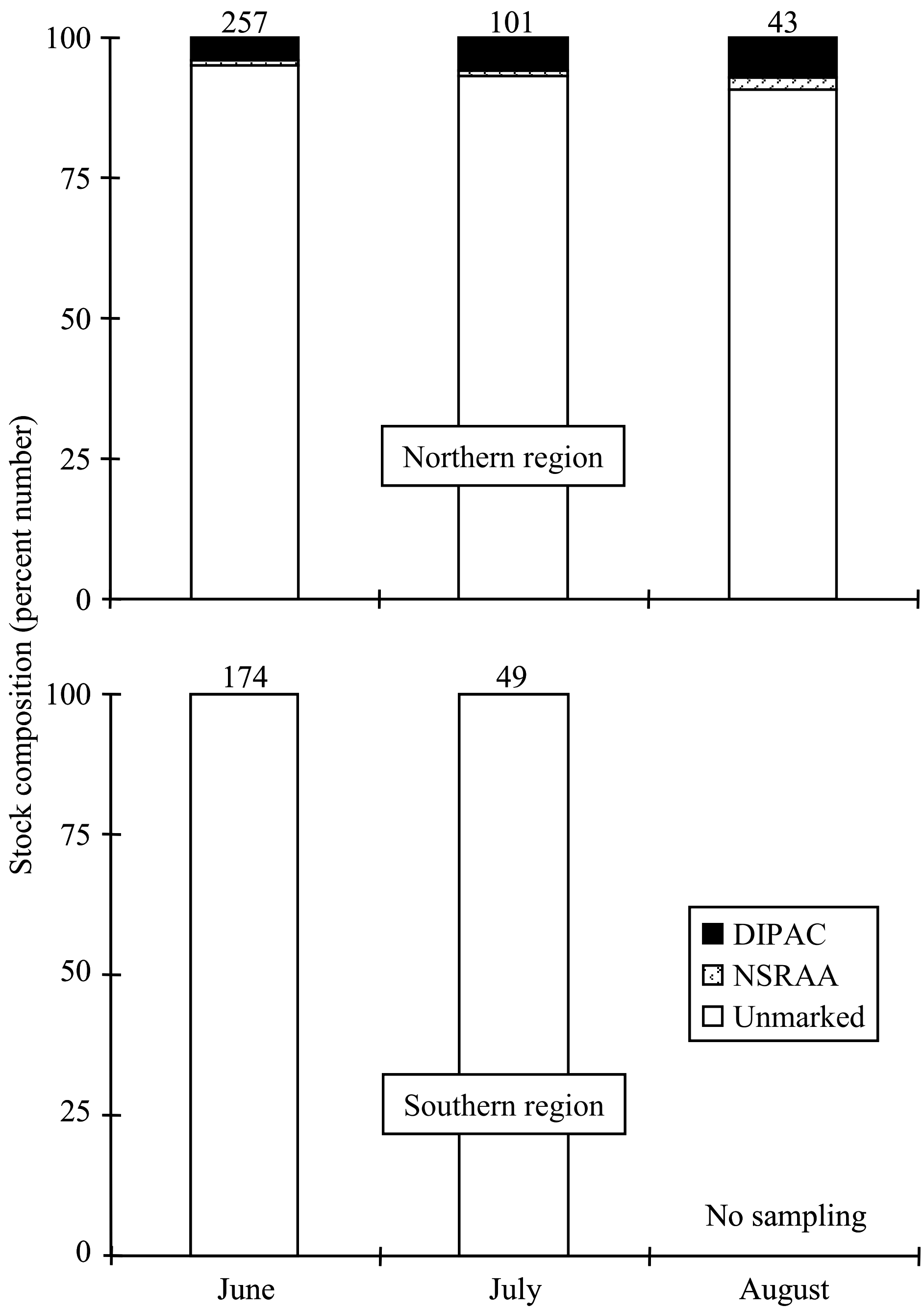

Figure 12.—Monthly stock composition (percent number) of juvenile coho salmon based on otolith thermal marks in marine strait habitats of the northern and southern regions of southeastern Alaska, June–August 2005. Number of salmon per month and habitat is indicated above each bar.

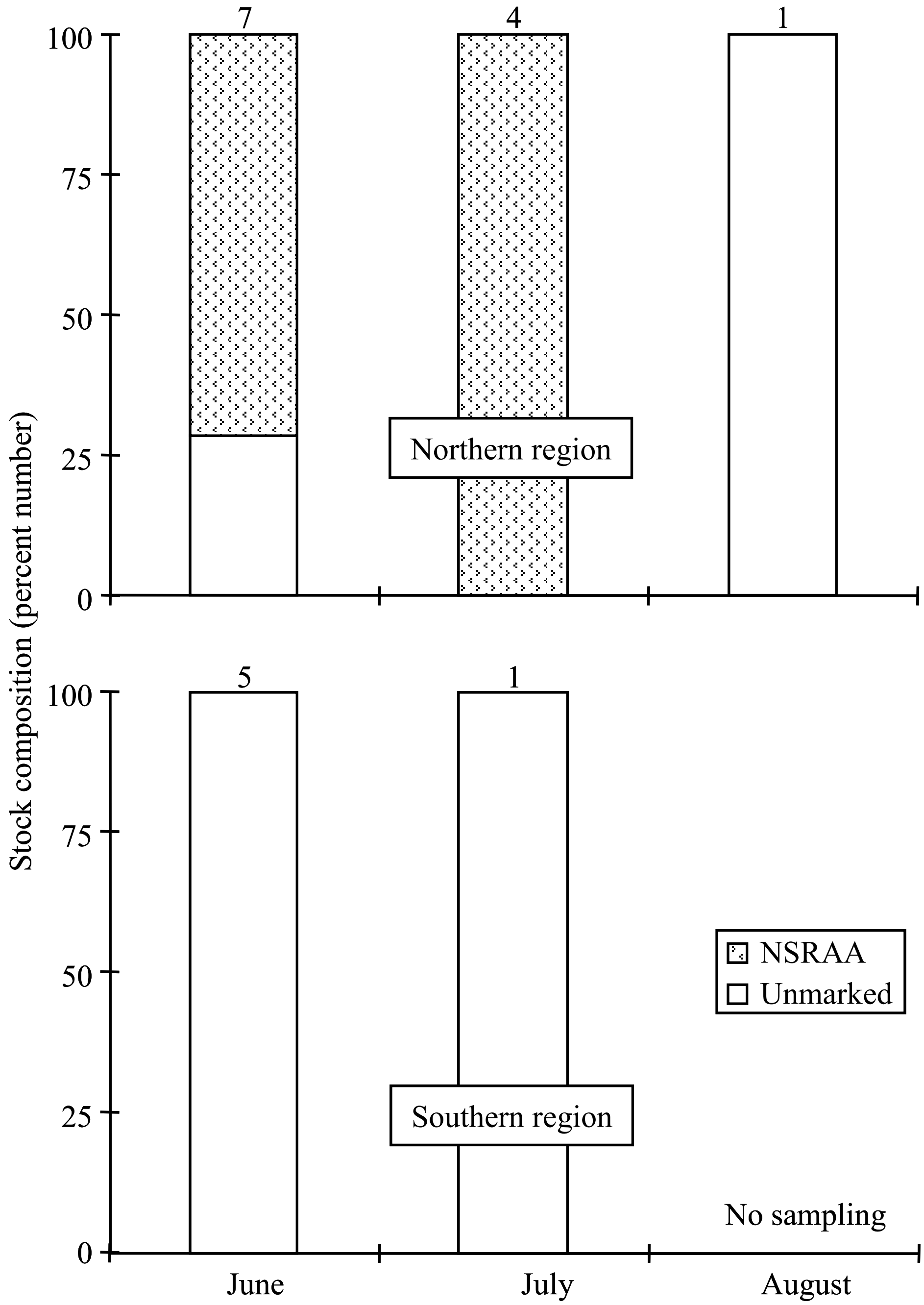

Figure 13.—Monthly stock composition (percent number) of juvenile Chinook salmon based on otolith thermal marks in the strait and coastal marine habitats of the northern region of southeastern Alaska, June–August 2004. Number of salmon per month and habitat is indicated above each bar.

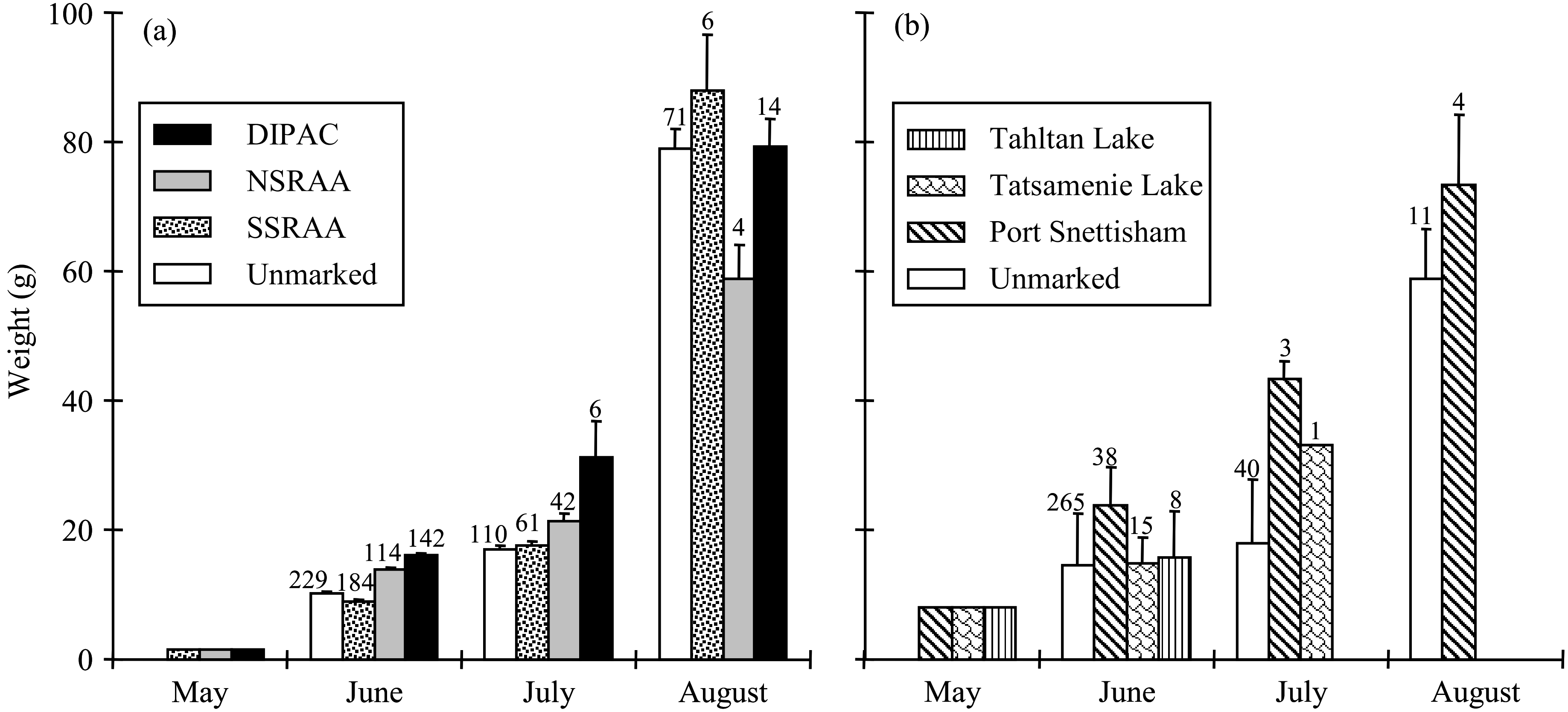

Figure 14.—Stock-specific growth trajectories of juvenile chum (a) and sockeye (b) salmon captured in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Weights of May fish are mean values at time of hatchery release. The sample sizes and the standard error of the mean are indicated above each bar.

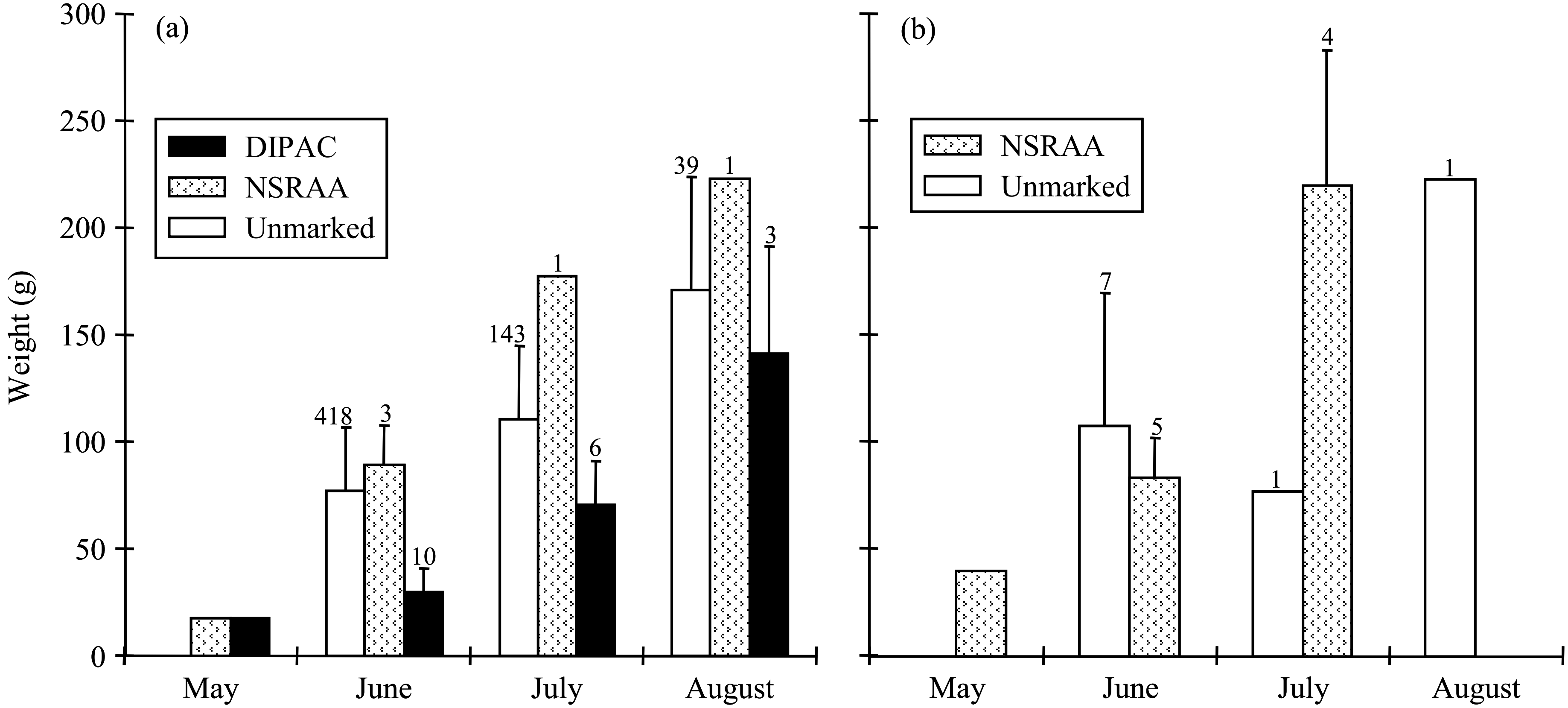

Figure 15.—Stock-specific growth trajectories of juvenile coho (a) and Chinook (b) salmon captured in marine strait habitats of the northern and southern regions of southeastern Alaska by rope trawl, June–August 2005. Weights of May fish are mean values at time of hatchery release. The sample sizes and the standard error of the mean are indicated above each bar.

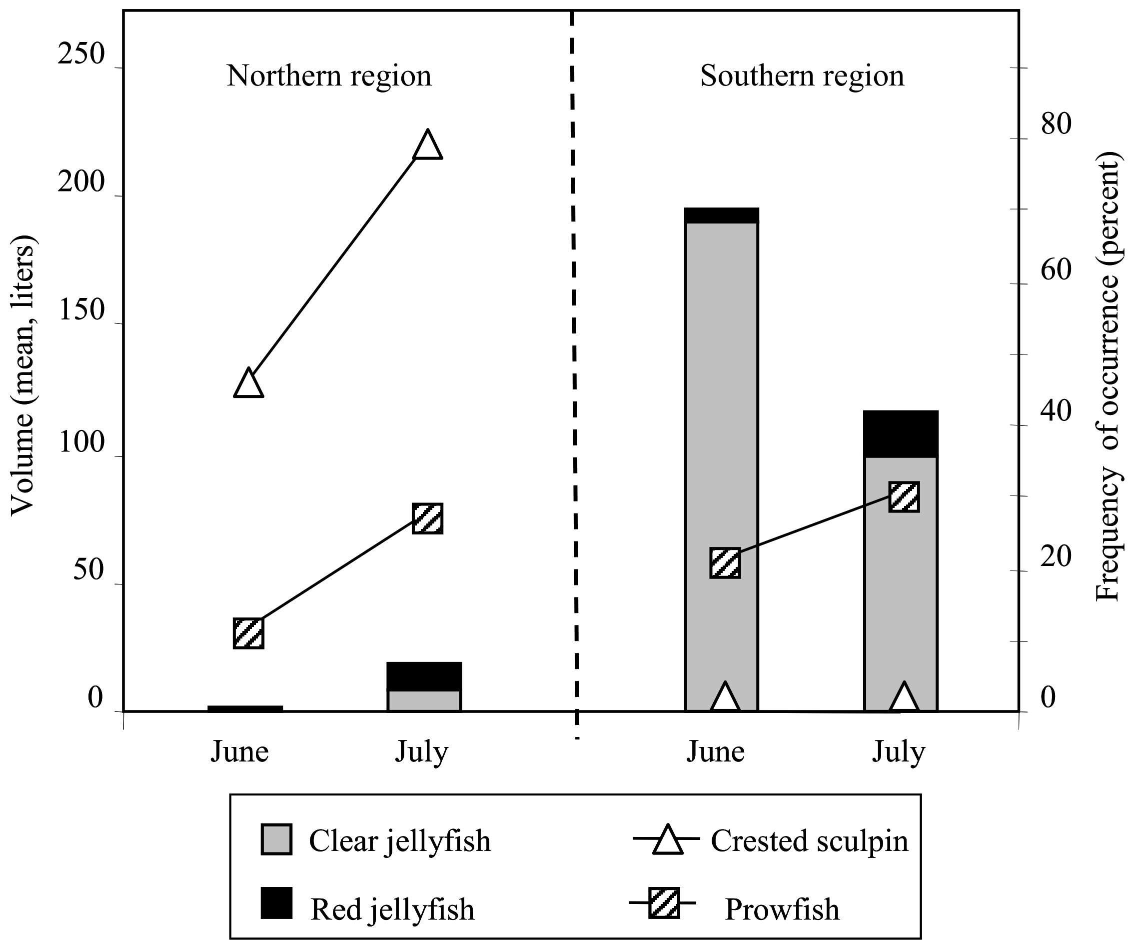

Figure 16.—Jellyfish and associated ichthyofauna captured in marine strait habitats northern and southern regions of southeastern Alaska by rope trawl in June and July, 2005. The volume of jellyfish is shown as bars and frequency of occurrence of crested sculpin and prowfish are indicated with symbols and lines.

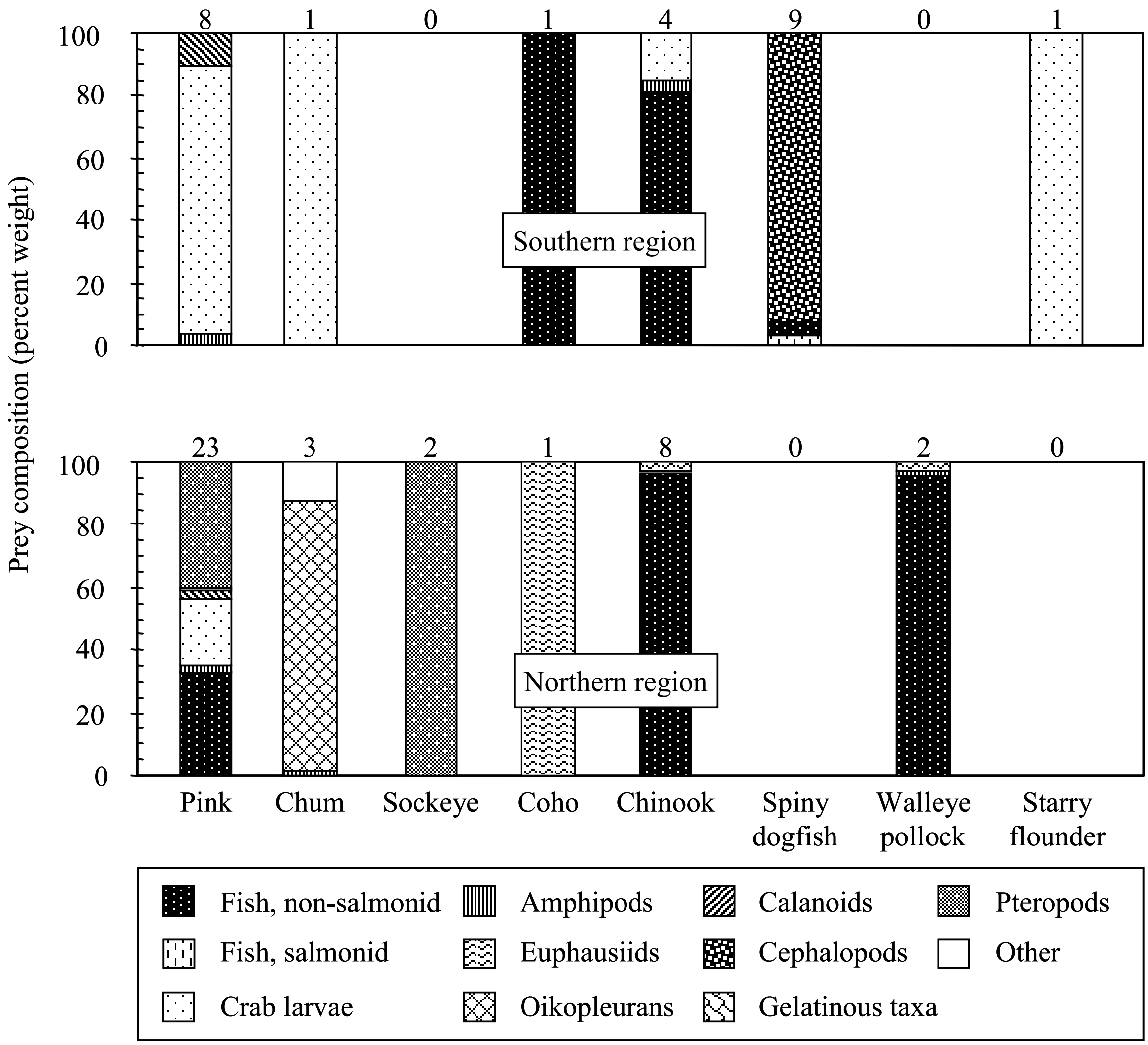

Figure 17.—Prey composition of potential salmon predator species captured in marine habitats of the southern and northern regions of southeastern Alaska by rope trawl, June-August 2005. See also Table 19 for feeding rates and Table 22 for predator size. The numbers of fish examined are shown above the bars.

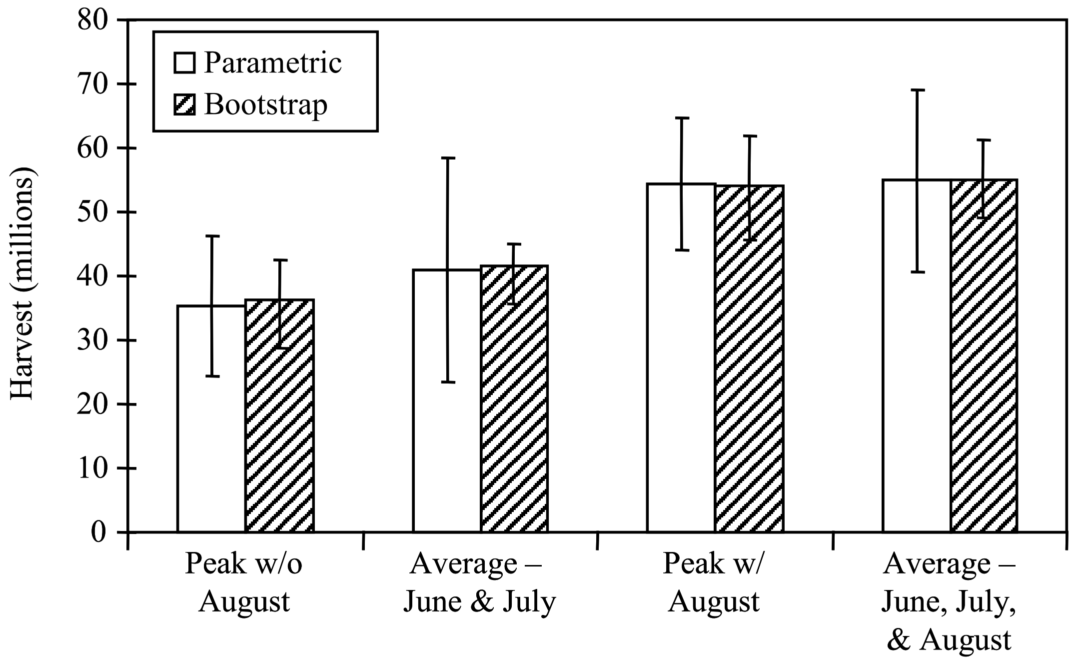

Figure 18.—Predictions of southeastern Alaska pink salmon harvest in 2006 from juvenile catch-per-unit-effort (CPUE) data in 2005 from parametric regression and bootstrap (80% confidence intervals).

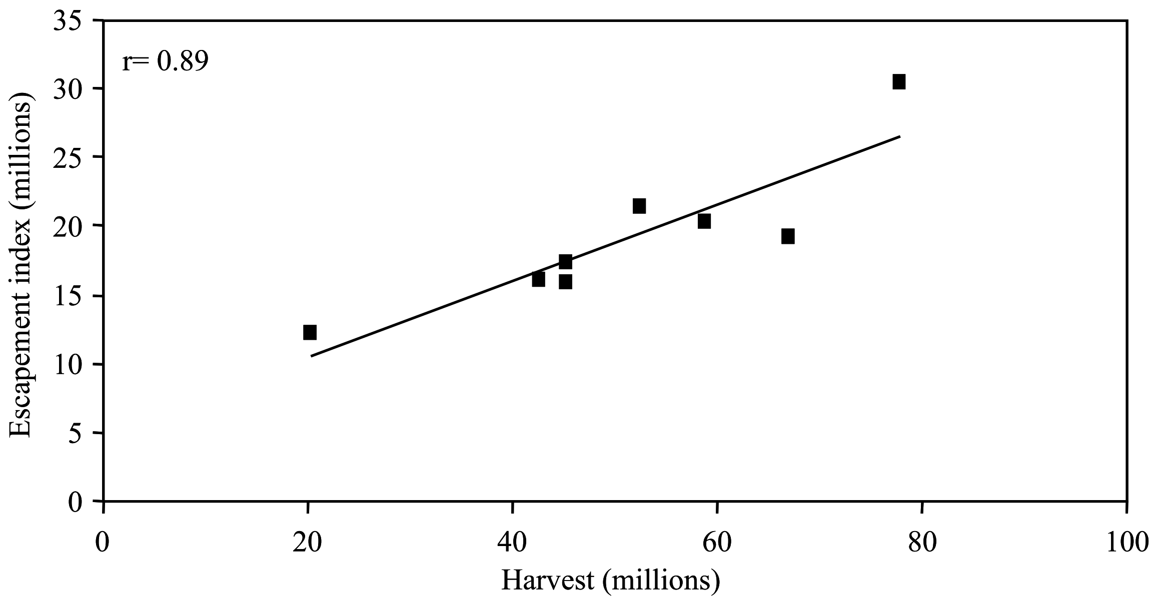

Figure 19.—Annual total escapement index and regional harvest for southeastern Alaska pink salmon, 1998-2005, with correlation (*r*) and trend line.

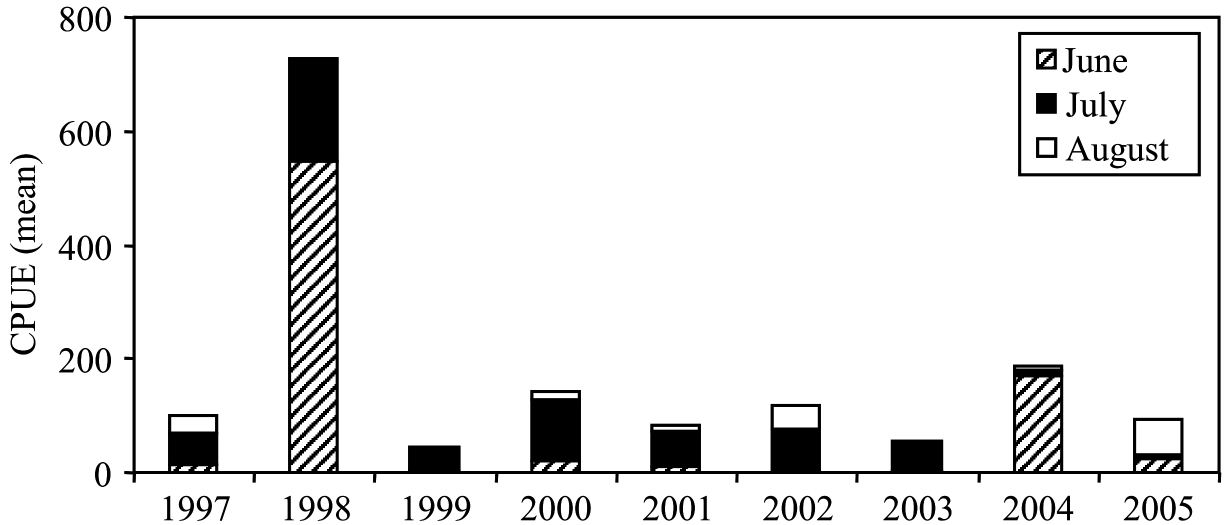

Figure 20.—Mean catch-per-unit-effort (CPUE) of juvenile pink salmon in marine strait habitats of the northern region of southeastern Alaska, 1997-2005.