Project #: 642

Title: Seasonal Distribution, Habitat Use, and Energy Density of Forage Fish in the Nearshore Ecosystem of Prince William Sound

Principle Investigator(s) and Recipient Organization(s): Scott Johnson, John Thedinga, Mandy Lindeberg, Ron Heintz, and Dr. Stanley Rice (NOAA Fisheries, Ted Stevens Marine Research Institute)

Contract period and Amount of Funding: April 2006-May 2008; $150K

Report Period: January 1 to June 30, 2007

Report Date: July 15, 2007

Lead Author of Report: Scott W. Johnson

Project Summary: This project will assess the seasonal distribution, habitat use, relative abundance, diel use, diet, and energy density of forage fish in the nearshore ecosystem of western Prince William Sound (PWS). This information is lacking because forage fish species are usually not targeted for assessment, and nearshore areas are seldom surveyed for fish habitat. Because nearshore habitats are vulnerable to human disturbance, a better understanding of how the nearshore environment supports ecologically important forage fish species is needed to help managers conserve forage fish populations and protect essential habitats. We know that several forage fish species use the nearshore environment, but we do not fully understand their dependence and fidelity to the different habitats types within the nearshore, or which habitats are more important for different life stages. In addition, we do not know the effect of season on the utilization of nearshore habitats or energetics of forage fish. This study will help address information gaps on forage fish by assessing 1) seasonal and diel use of nearshore habitats, 2) quantity and quality of habitat, 3) relative abundance, and 4) energy flux and relative growth through seasonal change.

Progress Summary

Seasonal Use of Nearshore Habitats: No field work occurred from January 1 to June 30, 2007. All field data collected in 2006 (three trips), however, has been added into an *Access* database and the fish catch data is presently available online in our *Nearshore Fish Atlas of Alaska* website–http://www.fakr.noaa.gov/habitat/fishatlas/ . Two field trips will be completed in 2007; in July, all sites sampled seasonally in 2006 will be sampled again to examine annual variability in fish catch, species composition, habitat use, and fish energetics. In addition, in late August 2007, a subsample of sites (e.g., eelgrass and kelp) sampled seasonally in 2006, will be sampled during the day and night to examine diel differences in habitat use.

Energy Density: The objective for collecting fish samples in 2006 was to obtain specimens for evaluating fish condition in different habitat types. Measures of fish condition included Fulton's condition factor, lipid content, and energy density. In order to maximize the number of observations, bioelectrical impedance analysis (BIA) was employed in the field to estimate the latter two values. A total of 223 and 325 specimens were collected in July and September 2006, respectively. All specimens were brought to the laboratory where their wet and dry masses were recorded. Species included crescent gunnel, Pacific cod, Pacific herring, Pacific sand lance, saffron cod, and walleye pollock. Not all of these species were encountered, however, in each habitat type in each sampling period.

A subset of the specimens brought to the lab was analyzed for lipid, protein and energy content to establish calibration curves relating BIA observations to lipid and energy content. Species specific calibration curves were developed using 20 fish from each species pooled across all sizes and sampling strata. Energy was determined from the summed calorific equivalents for the total lipid and protein mass observed in each fish. Lipid derived energy content was estimated as 36.43 kJ/g and protein as 20.10 kJ/g. Fulton's condition factor (*K*') was calculated as:

$$K' = \frac{100 \times w}{l^b} \times 10^5$$

Where *w* was wet mass in g, *l* the length in mm and *b* the allometric scalar relating length and weight. Calibration curves were developed by relating lipid or energy content of fish to a series of functions of reactance, resistance, and electrode distance following Cox and Hartman (2005). The best curve was selected as that with the highest correlation coefficient. For example, the best curve for predicting lipid content of herring had an r^2 of 0.801.

Observations of BIA parameters made in the field were fit to these calibration curves to predict the total energy of fish sampled in the field. Lipid and energy contents for a given species were then compared between habitats by one-way ANOVA. For example, the estimated lipid content of herring collected from kelp and bedrock habitats differed significantly in September ($P = 0.019$). The estimated average lipid content of herring sampled from kelp habitats was 4.2% of wet mass compared with 3.2% for those collected from bedrock habitats. In contrast, Fulton's condition factor did not differ between habitats ($P = 0.580$) and averaged 8.3. These fish were primarily age-0 fish; average length was 52 mm FL. Our ability to resolve differences in lipid content of herring from different habitats derived from the relatively large numbers of fish we processed. A total of 107 were compared between habitats. Thus, BIA appears to be a promising method for identifying differences in the condition of fish and may therefore become a useful tool for identifying essential fish habitats.

Energy content of fish was measured with a Bioimpedance Analyzer. This relatively new technique was tested on several species of fish (e.g., saffron cod, crescent gunnels, Pacific herring) collected from three different habitat types (eelgrass, kelp, and bedrock).

At eelgrass sites, we measured percent cover, canopy height, and approximate size of beds. Fish catches were highest in eelgrass and kelp and least in bedrock habitats.