EVOSTC ANNUAL PROJECT REPORT

***Project Number:* 10100132-G**

***Project Title*: 10100132-G, PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring in Prince William Sound**

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Time period covered: FY 2011

Date of Report: September 1 2011

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Project website: http://www.pwssc.org/research/biological/PacificHerring/pacificherring.shtml

Work Performed

The focus of this project is to assess the potential for fish predators to regulate juvenile herring recruitment. We used a combination of traditional field surveys and gut content analyses to examine the suite of fish preying on juvenile herring. Our study is designed to complement and expand on other concurrent herring studies that are part of the integrated Prince William Sound herring survey program.

Since FY2010, surveys for fish preying on juvenile herring have been conducted 4 times: 12-19 November 2009, 17-23 March 2010, 2-14 November 2010, 8-18 March 2011. Cruises primarily focused on five bays in Prince William Sound (fig. 1) known historically to hold large overwintering aggregations of juvenile herring: the four bays sampled as part of the EVOS Sound Ecosystem Assessment (SEA) program (Eaglek, Simpson, Whale, and Zaikof Bays), as well as Lower Herring Bay. The most recent two cruises also expanded upon these original sites and added 4-5 more sampling bays to the cruise track. Our field research was conducted in conjunction with multi-project cruises including surveys of juvenile herring biomass, fish and seabird predators, plankton, oceanographic conditions in nursery bays, as well as sampling of juvenile herring schools for species composition, energetics and disease.

Sampling methodology has developed since the November 2009 and March 2010 pilot season. During the last two cruises (November 2010 and March 2011) fishing consisted solely of gillnetting and longlining. Methodology described here refers to the latest two cruises, as the methodology from the first two cruises is detailed in the 2010 EVOSTC Annual Report.

Longline sets were preceded by the setting of two gillnets perpendicular to shore approximate to sunset and sunrise (one evening and one morning set per bay) and soaked for three hours. Gillnets consisted of one net with three, 40’ x 16’ panels of 0.12, 0.20, and 0.44 mm mesh stretched and one net with three, 30’ x 25’ panels of 0.23, 0.40, and 0.47 mm mesh stretched.

Each longline consisted of a 530 m (1 skate) mainline with approximately 200 gangions (exact number recorded for each set). Each gangion was ~60 cm long with approximately equal numbers of #13/0, #11/0 and #9/0 offset-shank circular hooks baited with a non-local species of squid.

All fish captured were measured for total length and weight prior to removal of stomachs for dietary analyses. Stomachs were individually wrapped in cheesecloth and first preserved in 10% formalin, then transferred to 50% isopropanol until analyses could be performed. All gut contents were shipped to the Fisheries Ecology Lab at the Dauphin Island Sea Lab, University of South Alabama. Stomach contents are currently being analyzed and otoliths found in stomachs or collected from unidentifiable fish have been sent to another lab for further identification. Stomach samples from the November 2009 cruise have been partially analyzed and a subset of the relevant results is presented herein. A more thorough presentation of these results will follow when the remainder of analyses is complete.

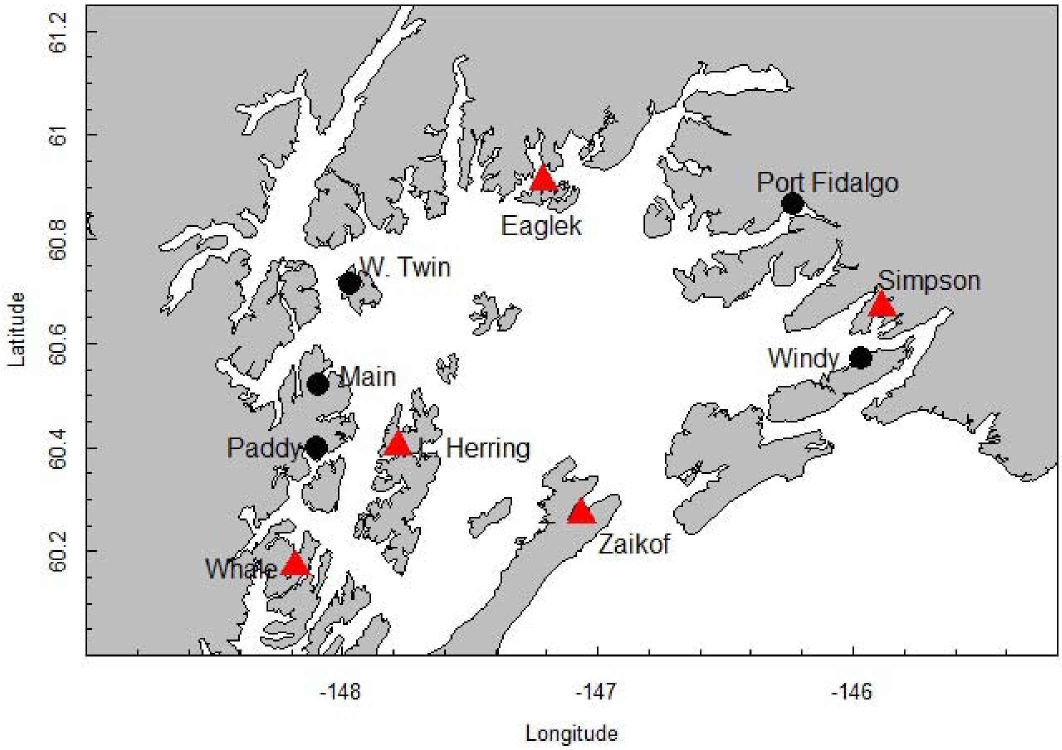

Figure 1. Sampling sites from 4 herring predator cruises. Red triangles were sampled during all cruises; black circles were sampled in Nov 2010 and Mar 2011 (Main Bay was sampled only during Mar 2011).

Preliminary data

The number of fish caught has increased substantially since the first two cruises (Table 1), which can be attributed to both refinements to sampling methodologies (eg., multiple hook and mesh sizes) and an increase in the numbers of bays sampled during those cruises.

Table 1. Numbers of fish caught by cruise and by gear type.

Cruise	**Gillnet**	**Longline**	**Total**
Nov 2009	15	93	**108**
Mar 2010	5	200	**205**
Nov 2010	381	372	**753**
Mar 2011	97	363	**460**
Total	**498**	**1028**	**1526**

The distributions of these catches have varied by gear type, cruise and bay (Figs. 1 – 3).

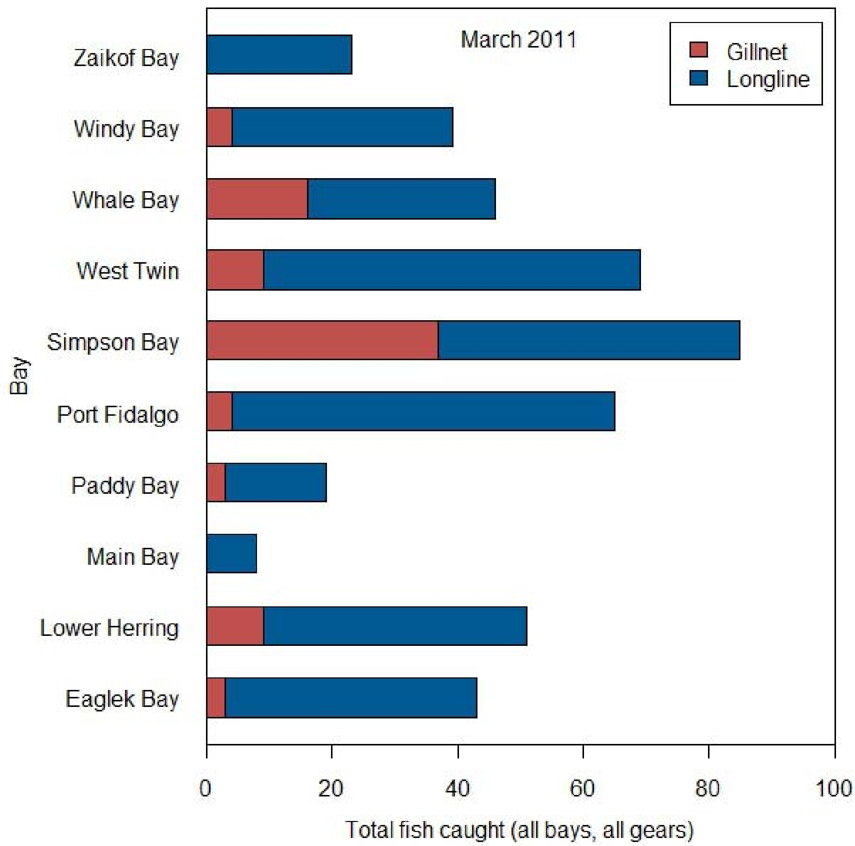

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Figure 1. Numbers of fish caught at all bays during March 2011 via longline and gillnet.

A total of 46 species of fishes have been caught during all four cruises though not all of these species were caught during each cruise. The full species list (common names) and an example of the distribution of species caught in one bay over all four cruises is provided in Figure 2. Catches were dominated in nearly all bays and on each cruise by gadids (fig. 3) with the exception of Simpson Bay where catches were composed largely of flatfishes (primarily yellowfin sole, *Pleuronectes asper*). The gadid category is composed of Pacific tomcod (*Microgadus proximus*), saffron cod (*Eleginus gracilis*), Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Theragrama chalcogramma*) , with the latter two species dominating the catches, as is exemplified by figure 2.

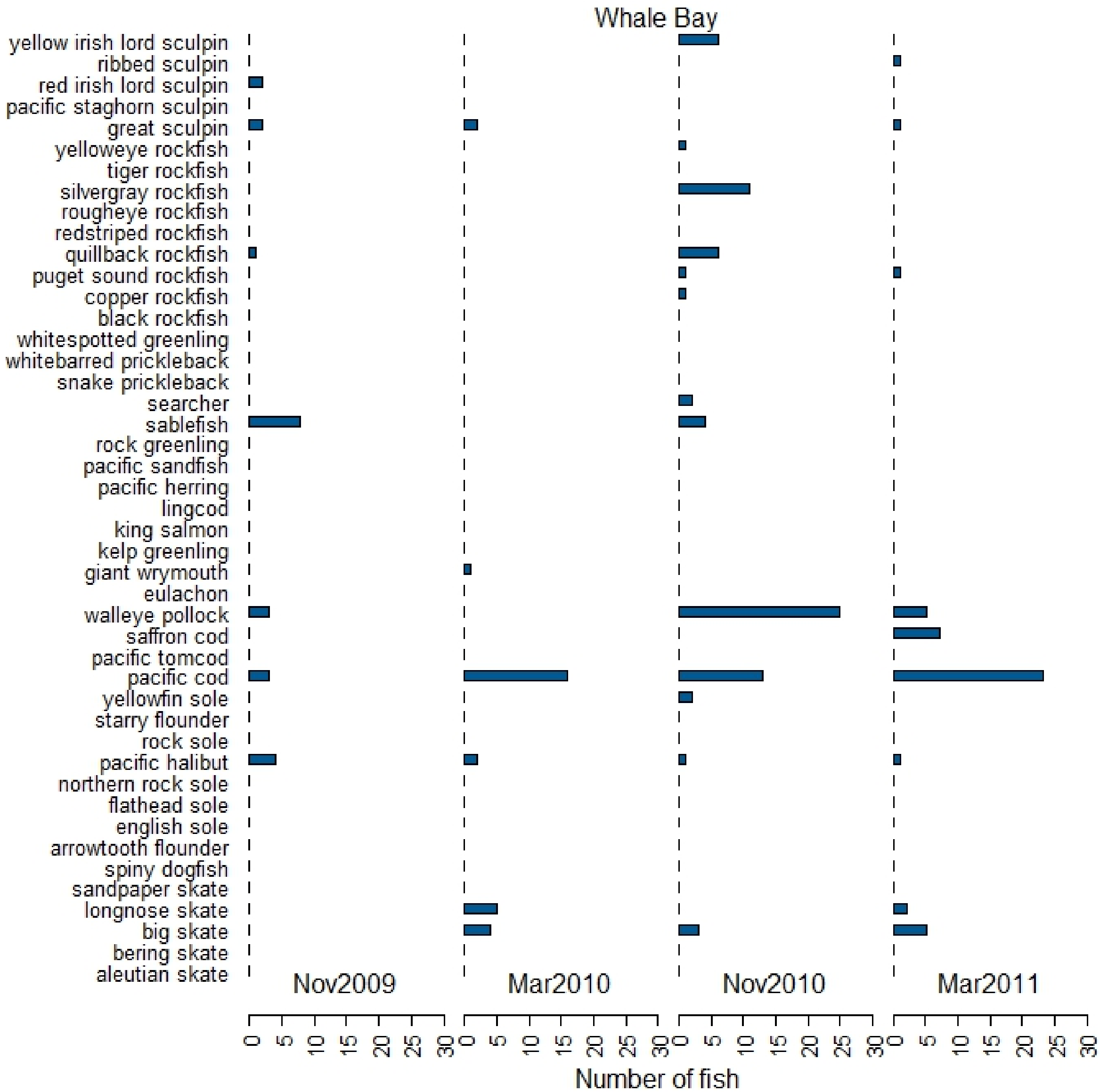

Figure 2. Number and species of fish caught at Whale Bay using all gear types during each of the four cruises. Species list represents all species caught at all locations throughout the sampling period.

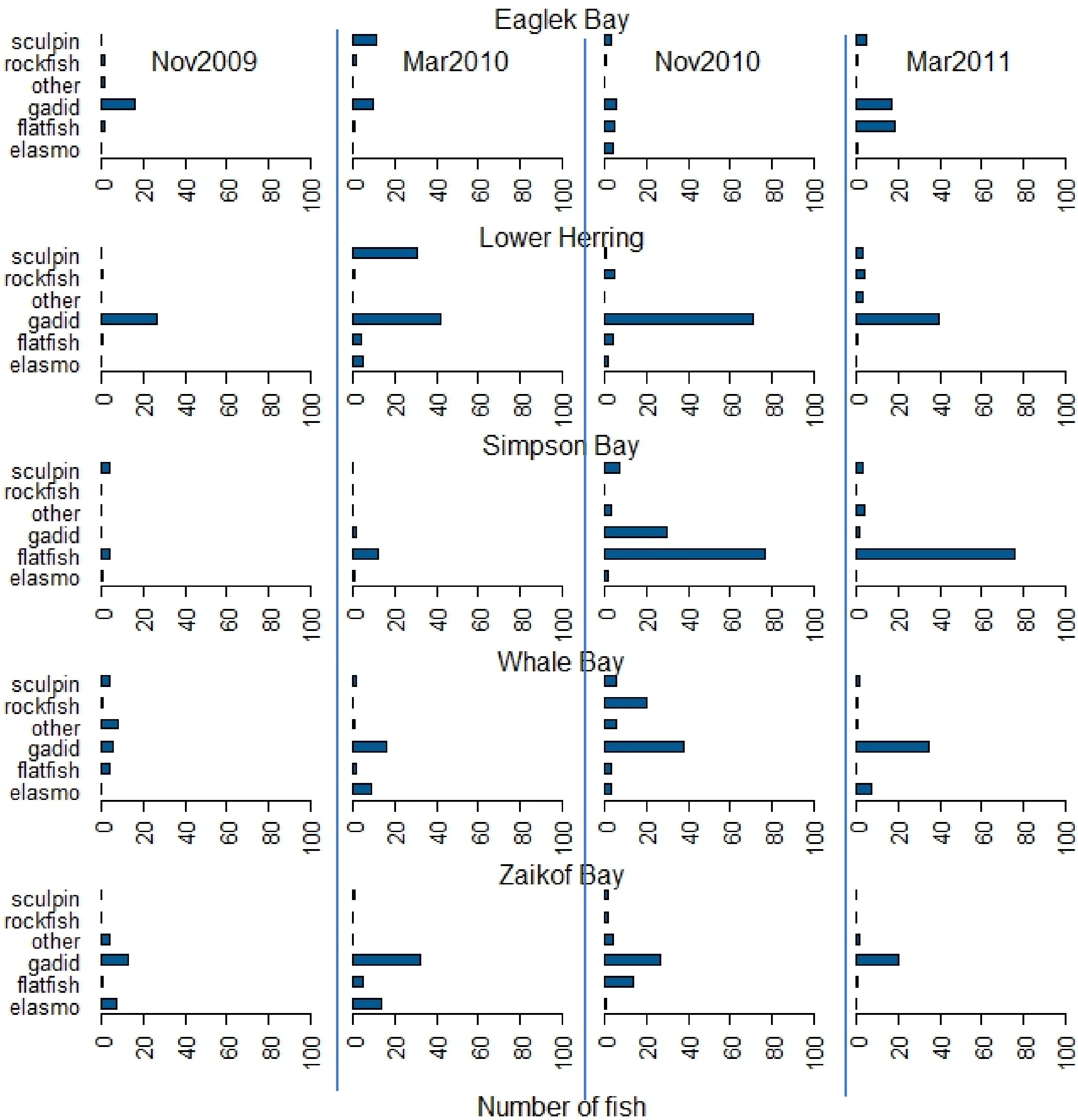

Figure 3. Fish caught at all bays during each of the four cruises, categorized by species groups. Elasmo = elasmobranchs.

A consolidation of our species distribution from one cruise allows us to observe how our approach has targeted types of predators by gear type (fig. 4). The driver of the flatfish catches was yellowfin sole (*P. asper*), caught by both gear types, in Simpson Bay. The gadid catches were dominated by walleye Pollock (*T. chalcogramma*) and Pacific cod (*G. macrocephalus*) in longline sets and a mixture of walleye Pollock (*T. chalcogramma*) and saffron cod (*E. gracilis*) in gillnet sets.

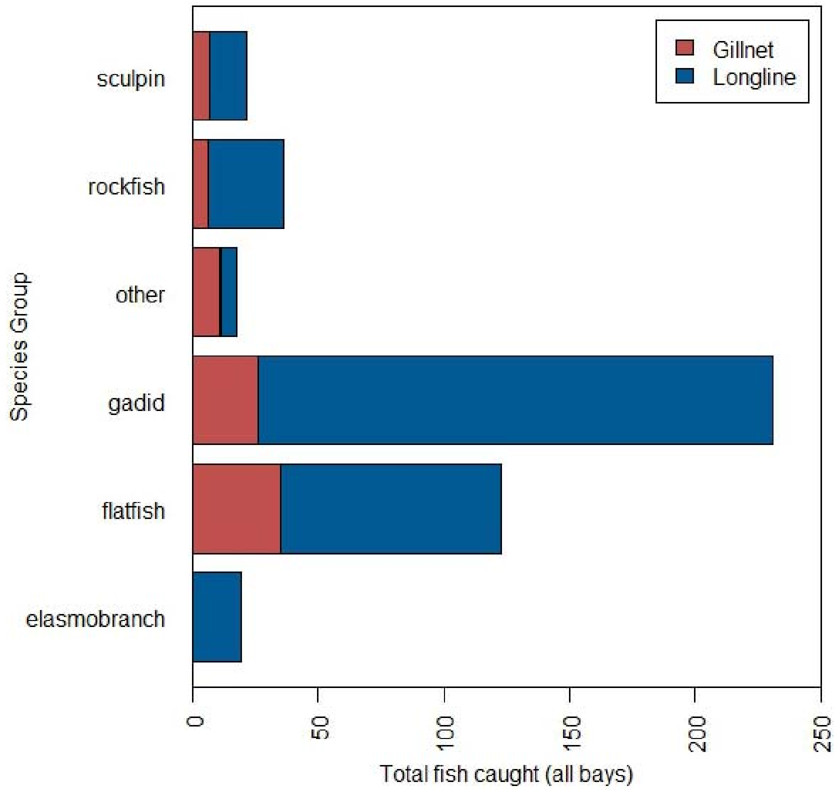

Figure 4. All fish caught during the March 2011 cruise, at all bays using longline and gillnet

Length-frequency analysis of these catches can be further used to determine how our sampling approach is targeting a range of size classes and thus predation behaviors. The expansion of our longline sampling, for example, to include 11/0 and 9/0 hook sizes has increased the size range of Pacific cod caught in our longline sets (fig. 5), and will allow us to better understand the role of a broader range of Pacific cod predation on juvenile herring recruitment. Additional hook sizes also increased the number of species caught during sampling.

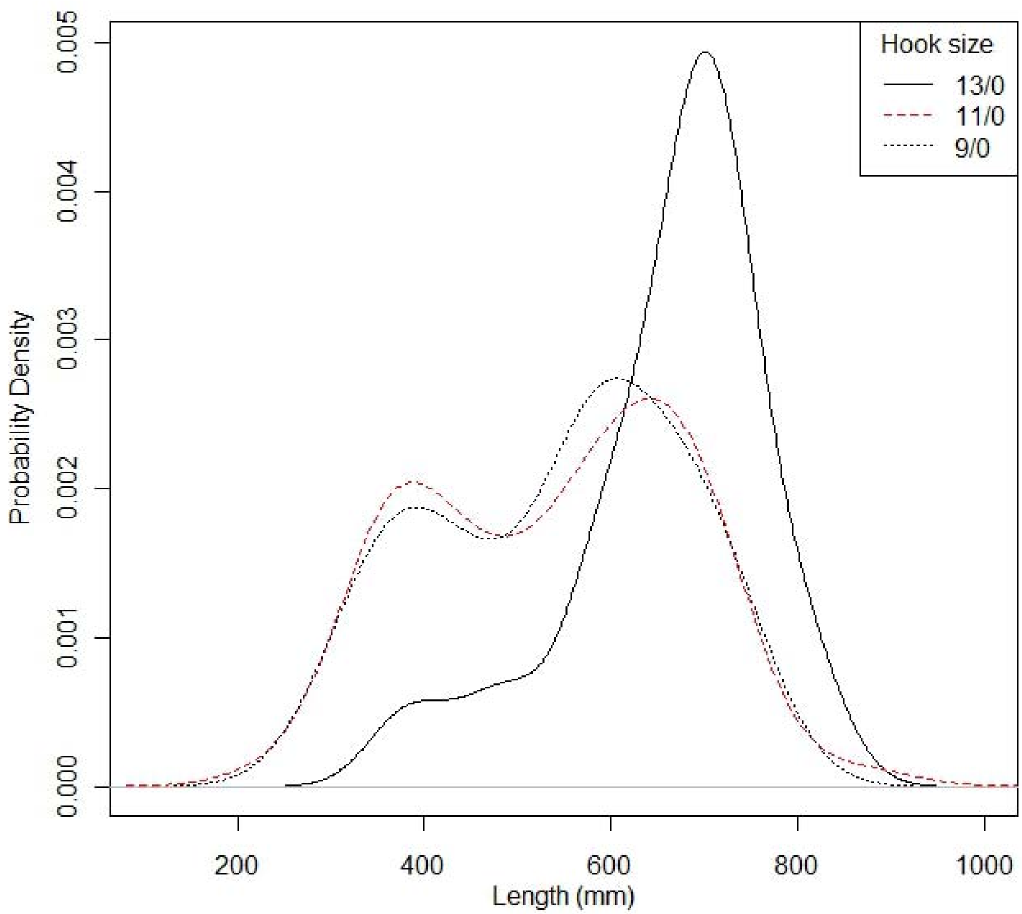

Figure 5. Length frequency distribution for Pacific cod caught via longlines during March 2011 at all bays.

Catch and effort

The majority of fishes were caught in longline sets (Table 1). Non-standardized catch per unit effort (CPUE) has been calculated as fish per hook per hour for all bays during each cruise by hook size (fig. 6). The high CPUE of *gadids* during March 2010 was driven by a large set of walleye pollock (*T. chalcogramma*; n = 68) and the relatively high CPUE of *other* was dominated by a large set of great sculpin (*Myoxocephalus polyacanthocephalus*; n = 31), both in Lower Herring Bay. During the first two cruises, only size #13/0 hooks were used, explaining the absence of these cruises on the bottom two panels of figure 6.

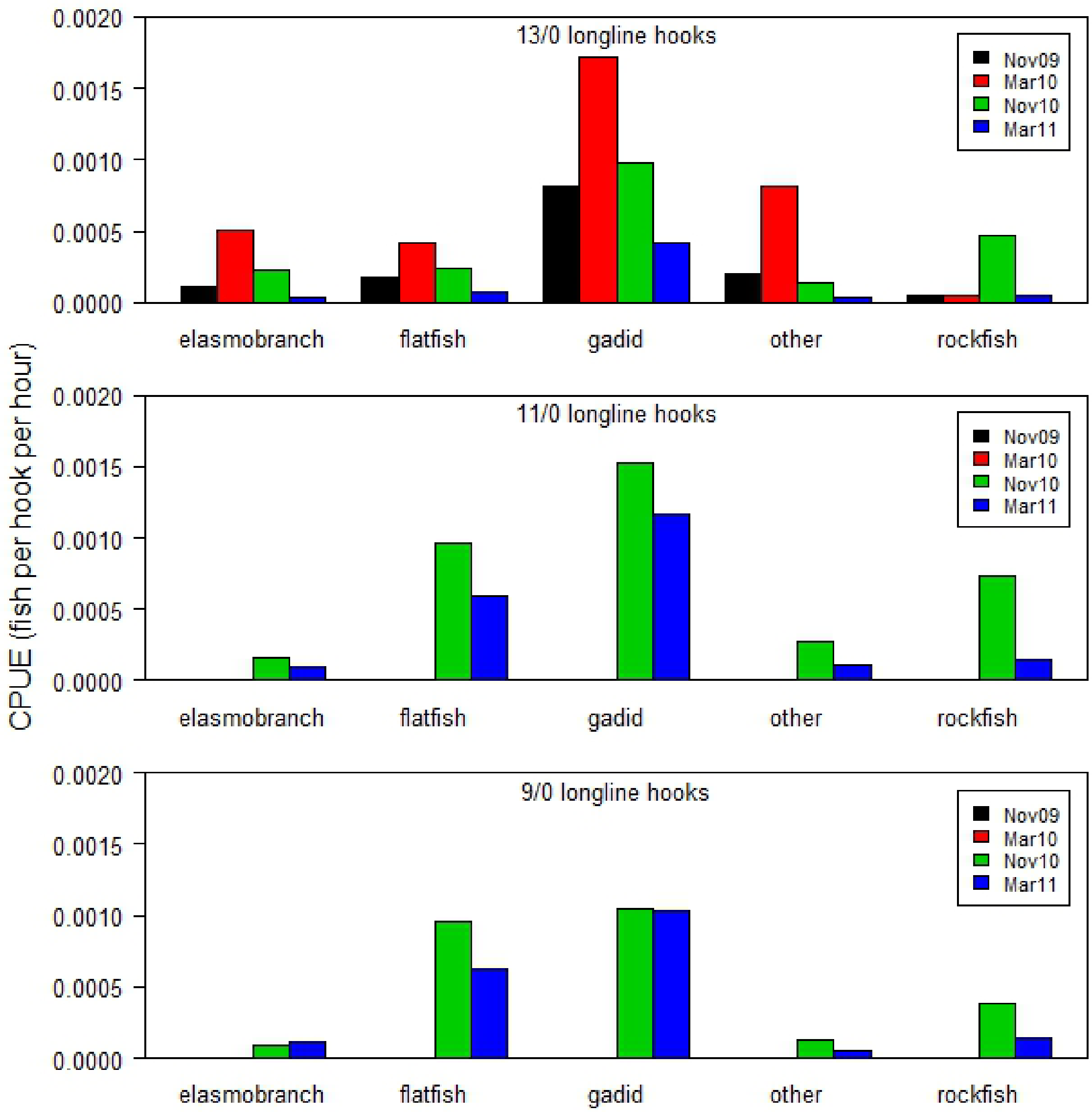

Figure 5. CPUE (fish per hook per hour) for species groups caught in all bays sampled during all cruises. Hook sizes 11/0 and 9/0 were not used during the November 2009 and the March 2010 cruises.

To compare numbers of fish caught during cruises more uniformly, we have also calculated the number of fish caught by each hook type in each of the 5 primary bays that were sampled on all four cruises. With all hook sizes, gadids (Pacific cod, walleye pollock) dominated the catch. Most flatfish catches were dominated by yellowfin sole and most sculpin catches were dominated by great sculpin with all hook sizes.

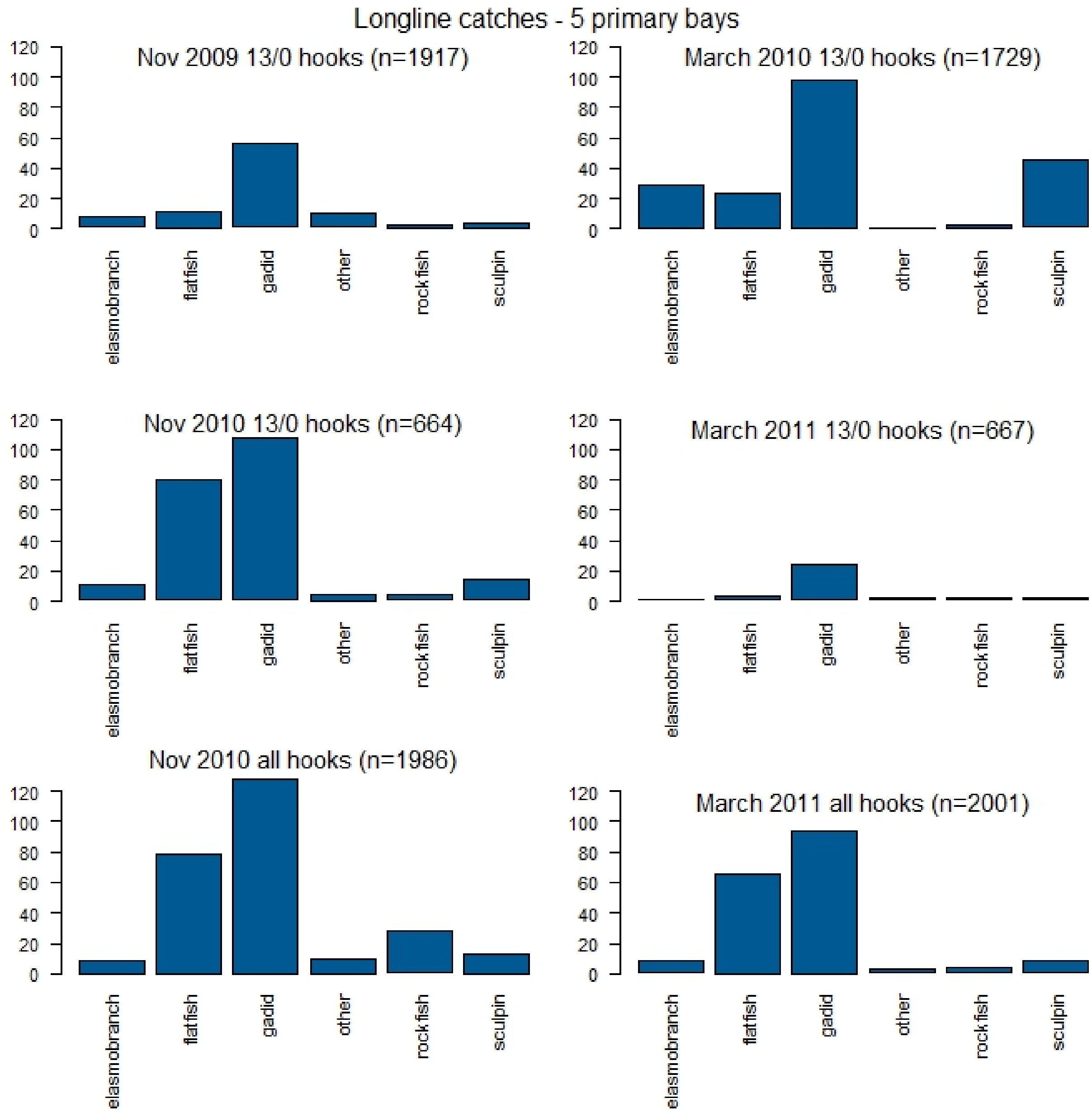

Figure 6. Distribution of species groups caught at the 5 primary bays via longline during all cruises. Only 13/0 hooks were used in November 2009 and March 2010. Hook sizes were split evenly on November 2010 and March 2011 cruises among 9/0, 11/0 and 13/0 hooks.

Stomach samples

Analysis of predator stomach samples is on-going, but a subset of diet analyses from November 2009 (Fig. 7) revealed that 67% of these cod stomach contents were fish and of those 67%, 16% of the contents were Pacific herring. These findings support our expecation that Pacific cod will be a primary predator of Pacific herring among our sampled predators. Furthermore, given that Pacific cod are the primary species of fish caught during our surveys, the role of Pacific cod predation on Pacific herring may prove to be substantial. Preliminary diet analyses have also found Pacific herring in Pacific halibut stomachs.

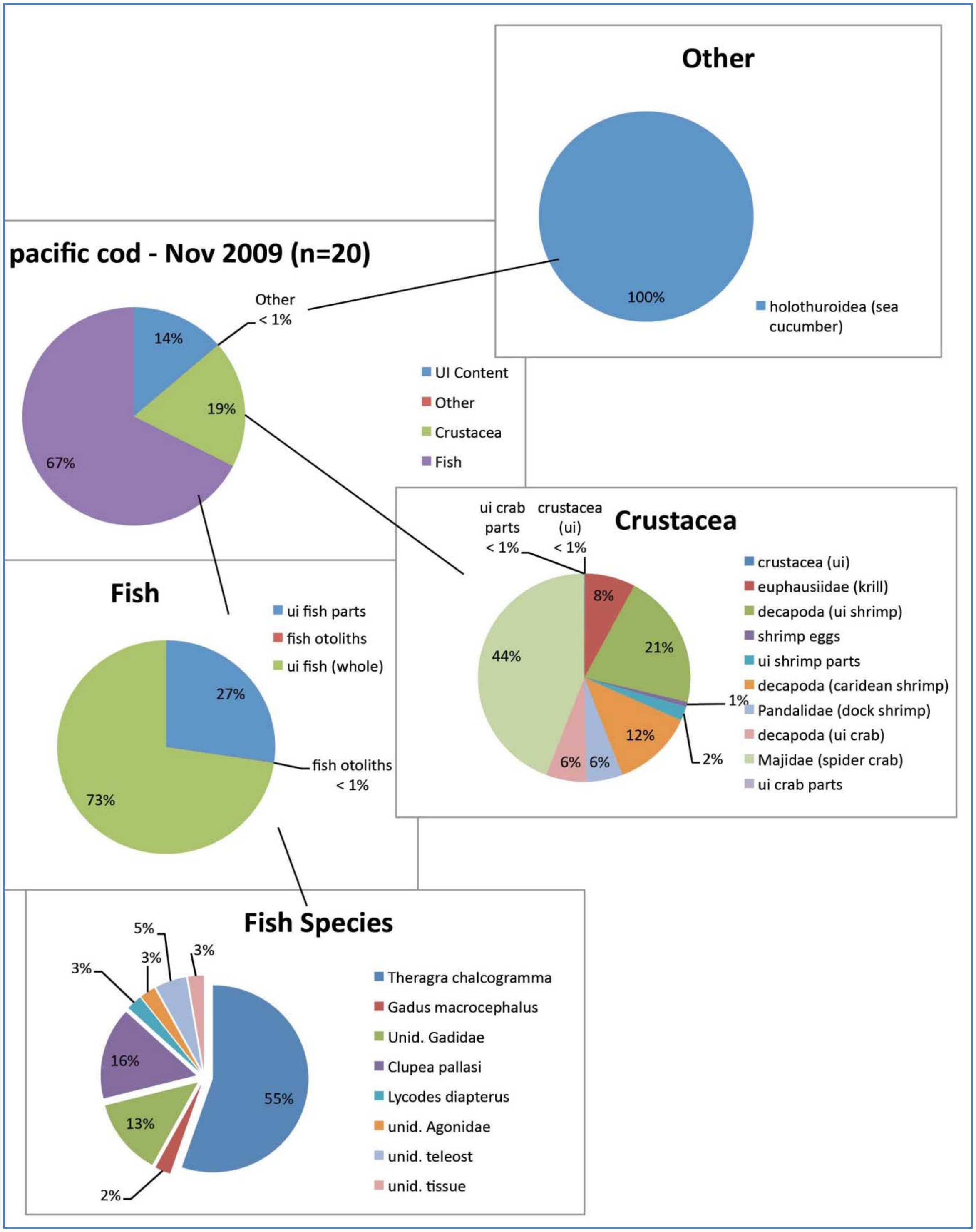

Figure 7. Analysis of 20 Pacific cod stomach samples from November 2009 cruise. “ui” and “unid” are both unidentified.

Future Work

We will continue our present methodology during the upcoming season'sNovember 2011 and March 2012 cruises. We will also continue our on-going development of a bioenergetics model that estimates consumption of juvenile herring by Prince William Sound fish predators. When more diet analyses are available, this model will be further refined and implemented.

Coordination/Collaboration

Our project is part of the Prince William Sound Herring Survey Group. Field work is conducted concurrent with energetics, disease, and hydroacoustic herring surveys, and avian predator observations. Principal investigators Bishop and Powers attended the May 2010 Herring Survey Group meeting in Cordova.

Community Involvement/TEK & Resource Management Applications

During the May 2011 Herring Survey Group meeting, held in Cordova, PI Powers presented findings from our study to the public and all of the PWS Herring Group principal investigators, including Bishop and Powers fielded questions from the local community.

Information Transfer

An article entitled, "Herring survey program examines the effect of predation on PWS juvenile herring" was written by Brad Reynolds for the 2010 Delta Sound Connections, an annual, free newspaper on science activities in Prince William Sound and the Copper River Delta prepared for general distribution to tourists visiting the area.

Public Outreach

Our project was featured along with the rest of the Prince William Sound Herring Survey Group in two "Field Notes" radio programs prepared by by Allen Marquette, an educator at the Prince William Sound Science Center. The programs were aired on KCHU Terminal Radio, the listener-supported public radio for Prince William Sound and the Copper River Valley. The station reaches more than 10,000 listeners, including the PWS communities of Valdez, Cordova, Tatitlek, and Chenega Bay and the interior communities of Glennallen, Copper Center, McCarthy and Kenny Lake. The *Field Notes* program for each week is aired on Sunday afternoon and Thursday evening. The two programs were initially aired in 2010, but have been rerun since.

Enhanced versions of these radio programs that include graphs and photos, are also available on Youtube.

Part 1 - http://www.youtube.com/watch?v=I37nv5Sq5fo

Part 2 - http://www.youtube.com/watch?v=mYW-2tNuV2U

Our project is now featured on the on the Prince William Sound Science Center's web site, under the PWS Herring Group web page:

http://www.pwssc.org/research/biological/PacificHerring/pacificherring.shtml

Budget Changes:

The species that are presently emerging to be the primary predators of herring in our study appear to have been the subjects of several bioenergetics studies in the past (Pacific cod, Paul et al. 1990; Pacific halibut, Paul et al. 1994), perhaps precluding our proposed need for mesocosm-based consumption and evacuation studies. If analysis continues to reveal these findings as such, budgeted funds may prove best allocated to the analysis of more stomach samples.

Paul, A.J., J.M. Paul, and R.L. Smith. Energy and ration requirements of juvenile Pacific halibut (*Hippoglossus stenolepis*) based on energy consumption and growth rates. 1994. J. Fish Biol. 44(6): 1023-1031.

Paul, A.J., J.M. Paul, and R.L. Smith. Consumption, growth and evacuation in the Pacific cod, (*Gadus macrocephalus*). 1990. J. Fish Biol. 37(1): 117 – 124