Forage fish distribution and abundance –Arimitsu and Piatt (USGS Alaska Science Center, 15120114-O)

FY15 PROJECT PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: Long-term monitoring: Pelagic monitoring component - Monitoring long-term changes in forage fish distribution, abundance, and body condition in Prince William Sound.

Project Period: February 1, 2015 – January 31, 2016

Primary Investigator(s): John Piatt and Mayumi Arimitsu, U.S. Geological Survey, Alaska Science Center

Study Location: Prince William Sound

Project Website (if applicable):

Abstract*: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon *et. al*. In response to a lack of recovery of wildlife populations following the Exxon Valdez Oil Spill (EVOS), and evidence of natural background changes in forage fish abundance, there was a significant effort to document forage fish distribution, abundance, and variability in Prince William Sound (PWS) since the 1990's. We propose to adopt some of these earlier sampling techniques, and also incorporate new methods to monitor forage fish in Prince William Sound with fishing and acoustic surveys of forage fish, and to measure indices of forage fish condition.

Estimated Budget:
EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
$209.9	$202.5	$202.5	$202.5	$150.0	$967.6

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
$339	$130	$130	$130	$110	$839

Date: September 2, 2014

I. EXECUTIVE SUMMARY

As originally proposed, the objectives of this work are to 1) identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term monitoring of those indices, 2) assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of Prince William Sound at selected times of the year, and 3) relate abundance and distribution of forage species to abiotic characteristics of the marine environment. We have made significant progress towards these goals.

During past reporting periods we worked closely with the Herring Research and Monitoring Program Manager and an experienced spotter pilot to come up with an improved survey design that increases encounter rate to sample target species. We supported the juvenile herring aerial survey work by providing equipment and expertise for data collection, management, and mapping. We analyzed a subset of recent aerial survey data collected in 2010-2012 by Evelyn Brown (Flying Fish Ltd.) to identify areas of high density forage fish schools observable from aircraft. We used this data to inform a new aerial-acoustic survey design that combines technologies to estimate near surface school abundance and distribution from the airplane, and simultaneously quantify deeper aggregations unobservable by the airplane with hydracoustic technology. We also devised a plan in collaboration with several GWA PIs to use humpback whales and foraging seabirds as indicators of deep water prey aggregations. We successfully carried out field sampling and validation of aerial observations in Prince William Sound in July, although results were not available at the time of this report.

II. COORDINATION AND COLLABORATION

A. Within the Program

We have undertaken two major collaborative projects within the program:

1) Aerial-acoustic survey for forage fish (see section III part B, below) with Scott Pegau (PWSSC), HRM coordinator. We have been working closely with Dr. Pegau during June 2014 aerial surveys and July 2014 forage fish surveys. We provided equipment and expertise in survey data collection and data management, including data recorders, software, mapping services, cameras and accessories. We analyzed historical aerial survey data and worked directly with the spotter pilot to come up with a statistically sound and feasible survey design with on-the-ground species and size class validation as well as concurrent hydroacoustic data collection.
2) Whale prey study with Jan Straley (UAS) and John Moran (NOAA), GWA humpback whale PIs, and Mary Anne Bishop (PWSSC), GWA fall and winter seabird abundance PI. We have devoted vessel time in July and September 2014 to facilitate a broader understanding of humpback whale and seabird foraging dynamics and forage fish availability in Prince William Sound. We are sharing research platforms and collaborating on survey techniques that will benefit all of our collective program components.

B. With Other Council-funded Projects

N/A

C. With Trustee or Management Agencies

N/A

III. PROJECT DESIGN – PLAN FOR FY15

A. Objectives for FY15

The objectives of this work are to:

1) Identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term measurement of those indices,

2) Assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of Prince William Sound (PWS) at selected times of the year, and

3) Relate abundance and distribution of forage species to abiotic characteristics of the marine environment.

B. Changes to Project Design

We have made significant progress and are on track to achieve our goals. The following details modifications that were made to the original study plan, and the rational for making those changes.

We developed a pilot study design, details of which are found in the original sampling protocol for this project on the AOOS ocean workspace. Based on findings during historical work on forage fish and our surveys in 2012-13, we modified the study design for the 2014 field season (detailed in a protocol changes for project 12120114 document, available on the AOOS ocean workspace. The changes we implemented in 2014 will improve our ability to meet the project objectives by modifying historical aerial survey methods to increase repeatability and ensure certainty in species composition and school density, as well as simplify the data collection and processing effort. To increase encounter rate for target species we sampled a subset of aerial survey areas with acoustic and net-capture methods, we used a spotter plane to identify forage schools in near-surface (< 10-15 m) waters, and used foraging humpback whales to locate and sample forage aggregations in deeper waters (> 10-15 m). We also collected habitat information to better understand the distribution and abundance of forage species throughout the Sound.

Previous work on forage fish in PWS includes acoustic and aerial survey methods developed during the mid-late 1990's, including the Alaska Predator Ecosystem Experiment (APEX) and the Sound Ecosystem Assessment (SEA). Additionally, the Sound-wide aerial surveys for forage fish were repeated in 2010-12 as part of the PWS herring survey. Although these programs had many useful outcomes, as detailed in numerous reports, publications and datasets, there were some issues with the historical acoustic and aerial survey methods that prevented us from repeating them as they were originally designed. The APEX nearshore acoustic surveys generally had low encounter rate (< 10%) with target species and had no effort in offshore waters. The APEX/SEA project and more recent aerial surveys for forage fish suffered from low validation effort, and methods that are difficult to repeat or estimate density with certainty (i.e., strip transects of unknown width or line transects placed parallel to the density gradient, which confound the estimation of a detection function). Furthermore, logistical constraints hampered coordination with concurrent acoustic and net sampling efforts in the past.

During 2012-2013 field seasons we conducted fish, seabird, zooplankton, oceanography and nutrients sampling at 27 fixed stations (although one site was sampled in both years) using a stratified systematic design. With the exception of euphausiids near tidewater glaciers, mid-water trawl composition at fixed stations throughout the Sound suggested our encounter rate with target species was not sufficient to assess abundance. Frequency of occurrence in trawls (FO) was low for capelin (3.7%), eulachon (3.7%), and euphausiids (11.1%), and catches were overwhelmingly dominated by non-target species (young of the year walleye pollock, FO = 100%, and jelly fish FO = 81.5%). Likewise, beach seines targeting Pacific

sand lance had low and variable catches (mean CPUE ± SD = 3.5 ± 10.5 fish per set). Thus we began to look for ways to improve our ability to sample target fish species.

In 2013 we explored the use of adaptive cluster sampling, and tested combined aerial and acoustic surveys with validation ("aerial-acoustic surveys") as means to increase our encounter rate with target species. Adaptive cluster sampling (i.e., intensive sampling right over schools we found during surveys or by chance) generally involved a high degree of effort and did not facilitate a quantitative means of assessing abundance and distribution at the sound-wide scale. We devoted 3 days of ship time to validation of limited aerial surveys. An experienced spotting pilot directed the ship or a skiff to forage fish schools visible from the plane. Schools were captured with nets, jigs, video, and hydroacoustics whenever possible. The ground crew recorded, and relayed to the pilot, information about fish species, fish size, and depth of the schools. After the pilot left, we conducted hydroacoustic surveys of the area, and we used mid-water trawls, gill nets, cast nets, dip nets, jigs, or video to confirm the species composition and fish size for conversion of acoustic backscatter to biomass.

Although this work facilitated a better way to target near-surface forage fish schools available for observation from a plane, our sampling efforts resulted in relatively low-encounter rate with forage schools below the depth visible to the spotter pilot (> 10-15 m). We know, however, that humpback whales are efficient predators of forage species (fish and euphausiids), and whale distribution may be a key indicator of high density prey patches at depths that are not visible to observers in a plane. Therefore we have undertaken additional collaboration with GWA humpback whale PIs and have developed a pilot study to quantify prey aggregations near foraging humpback whales.

From the results of past efforts (APEX/SEA programs and our surveys in 2012-13), we believe that use of a redesigned aerial-acoustic survey to assess nearshore, shallow, forage fish distribution and abundance in Prince William Sound will improve upon past survey strategies in quantifying a Sound-wide forage school index. The redesigned aerial-acoustic survey (Figure 1), with more repeatable methods and the ability to apply a detection correction factor to school counts by size and species, has greatest potential to provide a Sound-wide index of forage school availability because on-the-ground validation will provide confidence in species composition, size/age class, depth distribution and biomass. We also measured habitat variables (oceanography, chlorophyll a, nutrients, and zooplankton) at a subset of aerial-acoustic survey blocks. Finally, using humpback whales as indicators of high-density prey aggregations in deep water (> 10-15 m), in July 2014 we undertook a pilot study to measure deep water forage aggregations in humpback whale hotspots as a potential monitoring tool.

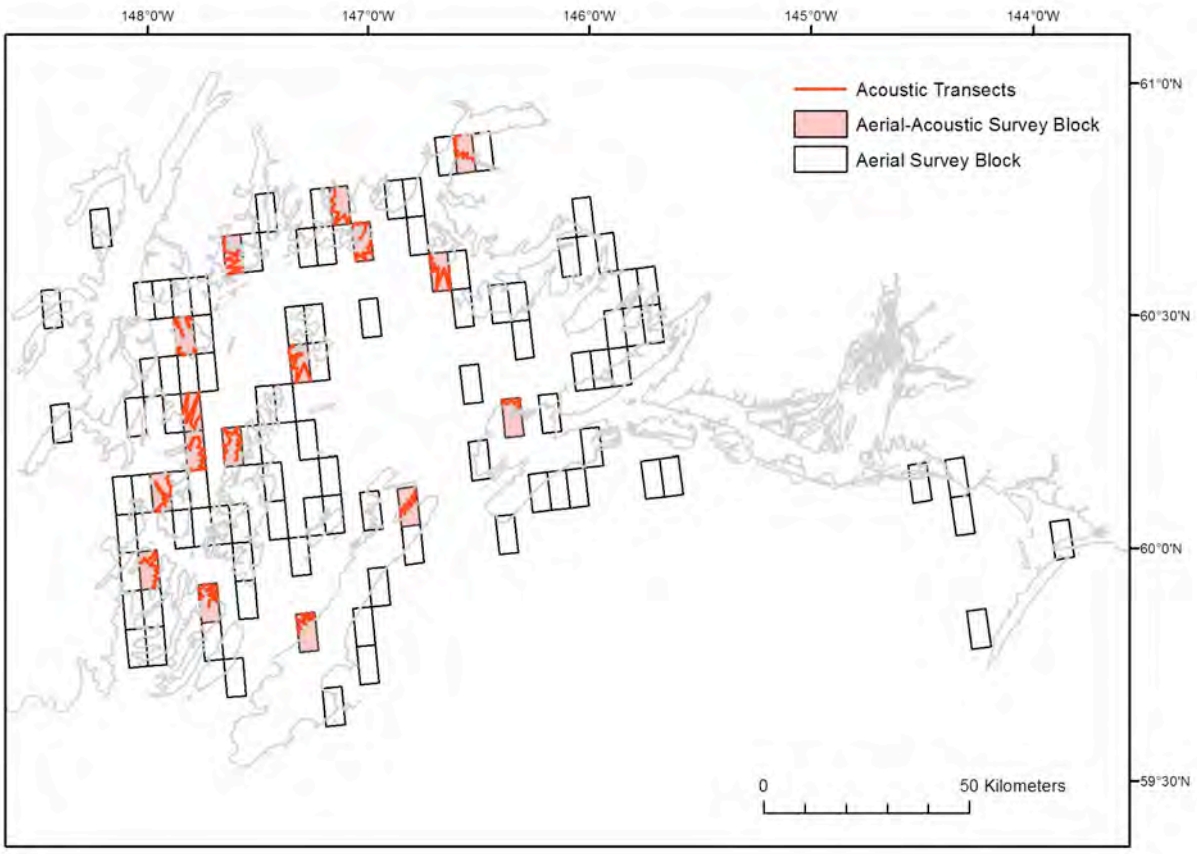

Figure 1. Map of aerial-acoustic survey design including survey blocks and acoustic transects in Prince William Sound, Alaska.

In 2014 we made the following additions to our project:

- Redesigned aerial-acoustic surveys with dedicated validation effort (addresses objectives 1 and 2)
- Continue measuring habitat variables at intensive acoustic sampling blocks (addresses objective 3, detailed in original proposed study plan)
- Pilot Study: target acoustic-trawl sampling near humpback whale hotspots and fixed transects in July and September (addresses objectives 1 and 2)

Although our survey design has changed considerably from the original proposed study plan, we will work within our original proposed budget to accomplish this work. The proposed additions to this project have been reviewed and approved by the following GWA and Herring Research and Monitoring (HRM) program members: Scott Pegau, John Moran, Jan Straley, Mary Anne Bishop, Mandy Lindeberg, and Ron Heintz. Additional comments to elements of the proposed design were discussed with Charlotte Wasting (ADF&G wildlife biologist in Prince William Sound), and Terry Quinn (UAF Fisheries Statistician). This work requires coordination and collaboration among PIs and will improve the quality of information gathered by the forage fish, herring, and humpback whale programs. Scott Pegau (PWSSC) will conduct aerial surveys as part of the collaborative project 1412011-R in 2014 and 2015. The July acoustic-trawl survey aboard the USGS R/V Alaskan Gyre will be reduced by 4 days to redirect some of our effort to collaborating on the 7-day NOAA coordinated whale prey survey aboard the M/V Montague in

September in 2014. Greater collaboration among projects within the GWA and Herring Research Program will ultimately benefit both programs and provide a greater understanding of forage fish availability and predator diets in the Sound.

IV. SCHEDULE

A. Project Milestones for FY 15

Objective 1. Identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term monitoring of those indices.
To be met by September 2016

Objective 2. Assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of PWS and at selected times of year.
To be met by September 2016

Objective 3. Relate abundance and distribution of forage species to abiotic and biotic characteristics of the marine environment.
To be met by September 2016

B. Measurable Project Tasks for FY 15

FY 15, 1st quarter (February 1, 2015 - April 31, 2015)

February: *Project funding available*
Feb – Mar *Update project outreach website, analyze and summarize data*

FY 15, 2nd quarter (May 1, 2015-July 30, 2015)

June: *upload 2014 data to workspace, update metadata*
July-Aug: *fieldwork*

FY 15, 3rd quarter (August 1, 2015 – October 31, 2015)

September: *2014 field data compilation, lab analyses*
November: *Annual PI meeting*

FY 15, 4th quarter (November 1, 2015- January 31, 2016)

December: *Begin analysis and report writing*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

N/A

VI. BUDGET

C. Budget Forms

Please see the program workbook.

D. Changes from Original Proposal

Our FY15 funding request does not differ from our original proposal.

E. Sources of Additional Funding

N/A