North Pacific Research Board
Gulf Project Semiannual Progress Report: Middle Trophic Level (MTL) Component

1. PROJECT INFORMATION

GOA IERP Project Number:	G82
Title:	Middle Trophic Level: Temporal and spatial axes of variability in the structure of Gulf of Alaska forage fish communities
Overall project duration	October 1, 2010 to January 31, 2015
Overall project funding	$1,858,400
Report period	December 1, 2012 to March 31, 2013
Report submission date	July 8, 2013
Lead Author of Report*	Olav A. Ormseth

Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):

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2. PROJECT OVERVIEW

a. Briefly (4-5 sentences) describe the core purpose of your project, and the underlying need for this research.

Forage fish link primary and secondary producers to upper trophic level (UTL) predators. The forage fish community includes small, fast-growing species such as capelin and sand lance, as well as juvenile stages of groundfishes (e.g. walleye pollock and Pacific cod). The MTL seeks to understand the ecosystem role of forage fishes as well as their predators, prey, and competitors by studying how forage fish communities and the GOA ecosystem varies over time (seasonally and annually) and through space (variation within regions and between regions). Sampling is being conducted in spring, summer, and fall of two years (2011 and 2013). The study area includes two main regions (eastern, comprising the outer coast of southeast Alaska, and western, comprising the east side of Kodiak Island and the southern coast of the Kenai Peninsula). Nearshore surveys are focusing on 5-6 sampling sites within each main region; offshore acoustic surveys throughout each region are being conducted aboard the UTL vessel; and diet and energetics studies are addressing relationships among species and the flow of energy among trophic levels. Oceanographic studies are being conducted aboard the nearshore surveys in collaboration with the LTL component. The MTL project is also contributing to the all-component retrospective analysis effort.

b. State the specific GOAIERP hypothesis or hypotheses that your project is addressing.

The MTL component is addressing all three of the overarching GOA IERP hypotheses:

1) The primary determinant of year-class strength for marine groundfishes in the GOA is early life survival. This is regulated in space and time by climate-driven variability in a biophysical gauntlet comprising offshore and nearshore habitat quality, larval and juvenile transport, and settlement into suitable demersal habitat.

2) The physical and biological mechanisms that determine annual survival of juvenile groundfishes and forage fishes differ in the eastern and western GOA regions.

3) Interactions among species (including predation and competition) are influenced by the abundance and distribution of individual species and by their habitat requirements, which vary with life stage and season.

c. List the specific objective(s) of your research project.

1) Provide a synoptic view of nearshore/offshore distribution and abundance (past and present) to gain a comprehensive understanding of how GOA forage communities are structured, how this structure changes in response to the environment, and the effects of this variability on prey availability for upper trophic level species.

2) Analyze habitat associations to determine how habitat needs influence the spatial overlap among species and resulting predation and competition.

3) Use analysis of stomach contents, stable isotopes, and fatty acids to infer diets and elucidate relationships among forage community members, lower trophic level prey, and upper trophic level predators.

4) Use proximate analysis to assess nutritional condition of community members and relate condition to spatial and diet overlaps among species.

3. PROGRESS SUMMARY

a. Provide a table showing the timeline and milestones for the current reporting period only.

	2012	2013		
	Dec	Jan	Feb	Mar
processing of all 2010 & 2011 inshore acoustics data	x			
analysis of inshore acoustics patterns		x	x	x
analysis of 2011 offshore acoustics data		x	x	x
analysis of 2011 fatty acid samples		x	x	x
preparation for 2013 field season		x	x	x
preparation for AMSS and PI meeting	x	x	x	x

b. Describe report period progress.

Objectives 1 & 2

Research activities: nearshore surveys, offshore acoustics surveys, retrospective analysis

Progress:

- Initial analysis of offshore acoustic data from 2011 is largely complete, and some basic seasonal and spatial comparisons have been performed (see results section).
- All inshore acoustic data has been analyzed and some preliminary investigations of temporal and spatial variability have been performed (see results section).
- Initial draft of a NOAA Technical Memorandum describing the results of the 2011 inshore field work is complete.
- All arrangements for the 2013 field season (vessel chartering, personnel, logistics, etc.) are either complete or in the process of completion.
- A fluorometer has been purchased for use in the inshore CTD.
- A 120 kHz transducer has been arranged for the offshore acoustics work.
- A new towbody and transducers have been purchased and assembled for the inshore acoustics work.
- Work continues on retrospective projects.

Objective 3

Research activities: analysis of stomach contents and tissues

Progress:

- Fatty acid (FA) analysis has been performed for all samples from the 2011 field season.
- Analysis of 2011 stomach contents has begun at the AFSC.

Objective 4

Research activities: proximate analysis of fish tissues

Progress:

- Energetics analyses are under way at the Auke Bay Laboratory.

c. Describe preliminary results.

The following are a selection of preliminary results from various component research activities.

Offshore acoustics

Acoustic backscatter (NASC) from the summer and fall surveys were compared for each transect by depth category to detect seasonal changes in the water column (Table 1). In the WGOA, backscatter in the 8 – 30m depth category declined by 81.4% across all transects from summer to fall, whereas backscatter throughout the rest of water column declined slightly (-9.3% in 30 – 250m, 0.3% in 250 – 500m). In the EGOA, a large decline in backscatter from summer to fall was also observed across all transects in the 8 to 30m depth category (-76.1%). In contrast, there was a more pronounced decline in backscatter throughout the rest of the water column in the EGOA (-32.4% in 30 – 250m, -35.4% in 250 – 500m). Along the Kayak Island transect in the CGOA, backscatter increased from the summer to fall, with a 34.1% and

108.5% increase observed in the 30 – 250m and 250 – 500m depth categories. A modest decline in backscatter was observed in the upper 8 - 30m (-31.4%).

Daytime acoustic backscatter measurements > -75 dB threshold were integrated over 0.5 nmi horizontal bins (nautical area backscatter coefficient – NASC), and partitioned into three depth categories based on the method used to verify acoustic targets: 8 - 30m (surface trawl), 30 – 250m (midwater trawl), and 250 – 500m (no direct sampling). Backscatter measurements were summarized for each transect as an index of biomass within each depth category (Figure 1).

Inshore acoustics
The 2011 backscatter data from all sites and seasons was partitioned into fish and zooplankton based on frequency responses (Figure 2). We present here some preliminary results. A generalized additive model was used to investigate the influence of seafloor depth, season, and site on total backscatter of fish and zooplankton. Depth had a substantial effect on fish and zooplankton, with greater abundance in deeper water. There were no obvious consistent spatial or temporal trends in the data, except that zooplankton abundance seems greater in spring. There was substantial variability in fish and zooplankton abundance among sites, and those differences appeared consistent among seasons (e.g. Islas Bay has consistently low abundance relative to Salisbury Sound).

d. Describe integration activity.

Retrospective analysis: We are an integral part of the retrospective team that has formed to coordinate the analyses.

General: Overall we have pursued integration with other GOAIERP components on many fronts. Fish catch data were combined with UTL and LT data to show connectivity; we are working on combining the MTL, UTL, and LTL oceanography data; and we are working with the modelers to define spatial boundaries and determine the best way to integrate MTL data in the models.

Energetics: Our energetics work is directly integrated with the UTL bioenergetics work. In addition, many of our samples will be used to determine the quality of prey available to seabirds, providing a further link to UTL work.

Diet: Our diet work is being carried out in cooperation with UTL diet work and the needs of the modelers. We expect that this level of integration will only grow as the project proceeds.

e. Describe any concerns you may have about your project's progress.

We do not have any concerns about our progress. We are still not where we would like to be with the laboratory analyses and the retrospective work, but these are underway and will not hinder other components' progress..

f. Poster and oral presentations at scientific conferences or seminars

- **Olav Ormseth**, "The Gulf of Alaska in 2011: The view from GOAIERP", oral presentation, Alaska Marine Science Symposium, January 2013
- **Dave McGowan and John Horne**, "Offshore density distributions of fish and macrozooplankton in southeast and central Gulf of Alaska", poster, Alaska Marine Science Symposium, January 2013
- **Olav Ormseth and Kim Rand**, "Seasonal nearshore fish sampling in the Gulf of Alaska using a small purse seine", poster, Alaska Marine Science Symposium, January 2013
- **Olav Ormseth and Kim Rand**, "Small-scale oceanography of the inshore Gulf of Alaska", poster, Alaska Marine Science Symposium, January 2013
- **Alex De Robertis and Olav Ormseth**, "Inshore acoustic surveys in the eastern and central Gulf of Alaska", Alaska Marine Science Symposium, January 2013
- **Olav Ormseth**, "An Update on Research Activities within GOA-IERP", Alaska Fisheries Science Center Seminar Series, January 2013

g. Education and outreach

In addition to MTL talks and posters at the Alaska Marine Science Symposium, Ormseth led a Wednesday evening workshop titled "Interdisciplinary research in the Gulf of Alaska- What's the rumpus?" This workshop brought together representatives of several current large-scale GOA research projects, as well as older projects such as GLOBEC and the earlier EVOS programs. It was very well attended. Ormseth also presented a seminar at the AFSC (see above) on general GOAIERP results.

4. PROGRESS STATUS

We feel our overall status is good. This period has mostly been spent getting ready for the 2013 field season and preparing for the AMSS and the GOAIERP PI meeting.

5. FUTURE WORKPLAN and DATA DELIVERY

Workplan

Note: We have included workplan dates that only include the next reporting period.

What	*Who*	*Start and end dates*
Preparation for 2013 field season	Ormseth/Rand	4/1/12-4/15/13
MTL inshore surveys	Ormseth/DeRobertis	4/15/13-11/1/13
MTL offshore acoustics work	Horne/McGowan	7/1/13-11/1/13
Energetics analysis	Heinz	4/1/13-10/1/13
Analysis of plankton samples	Ormseth (Hopcroft/LTL)	4/1/13-10/1/13
Retrospective data collection and analysis	Ormseth/Rand	4/1/12-11/30/13
Analysis of 2011 stable isotope samples	Budge/Wang	4/1/13-9/1/13
Analysis of stomach contents	Ormseth	4/1/13-11/30/13

Data delivery.

GOAIERP Data Delivery Table		
Data type for delivery	Delivery Month & Year	Person sending data, with email address
2011 stable isotope data	9/13	Alex DeRobertis (Alex.DeRobertis@noaa.gov)
2011 energetics data	10/13	John Horne (jhorne@u.washington.edu)
2011 zooplankton data	10/13	Olav Ormseth (olav.ormseth@noaa.gov)
2011 stomach contents data	9/13	Olav Ormseth (olav.ormseth@noaa.gov)

Table 1. Seasonal changes in offshore acoustic backscatter (NASC) by depth category across transects within each region. Number of transects indicates how many transects were sampled in their entirety during both the summer and fall surveys. Negative values indicate a decline in backscatter from summer to fall, positive values indicate an increase.

		Depth Category			
Region	# Transects	*Total*	*8 – 30m*	*30 – 250m*	*250 – 500m*
WGOA	6	-15.2%	-81.4%	-9.3%	-0.3%
CGOA	1	47.2%	-31.4%	34.1%	108.5%
EGOA	9	-37.6%	-76.1%	-32.4%	-35.4%

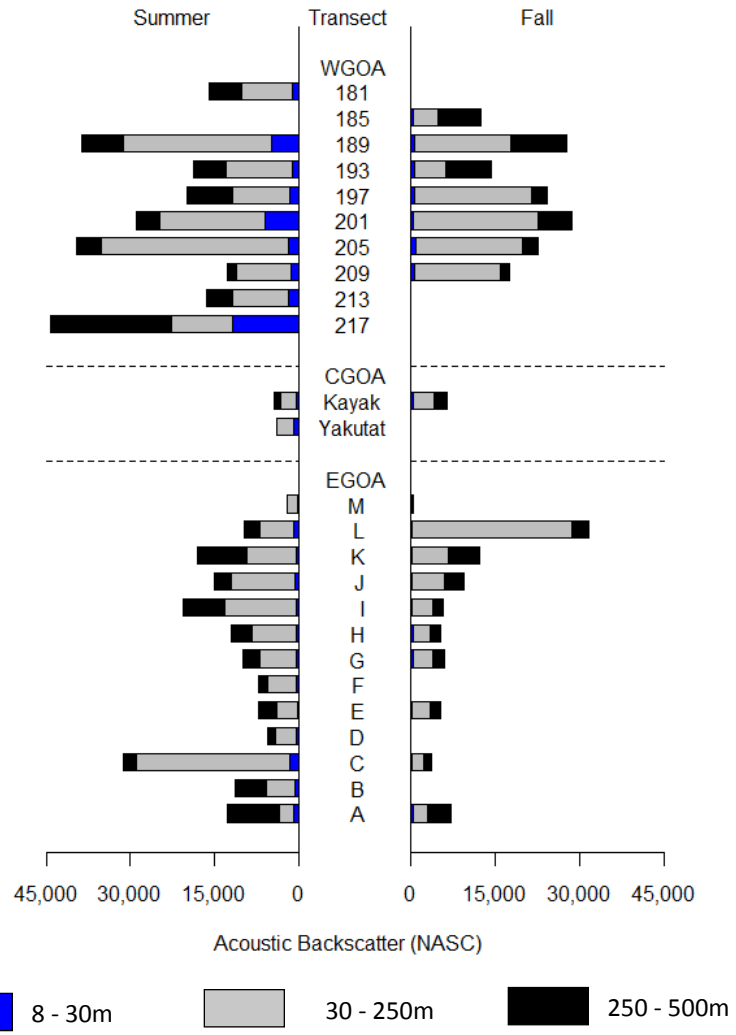

Figure 1. Results for the 2011 offshore acoustic survey by season. Acoustic backscatter (NASC) is summarized by depth category for each transect. Depth categories are represented by blue (8 - 30m), gray (30 - 250m), and black (250 - 500m) bars. Summer and fall surveys are shown on left and right columns, respectively. Transects with no data indicate sampling was not conducted during that season. *Transect SE-M was only partially sampled during the fall survey due to weather.

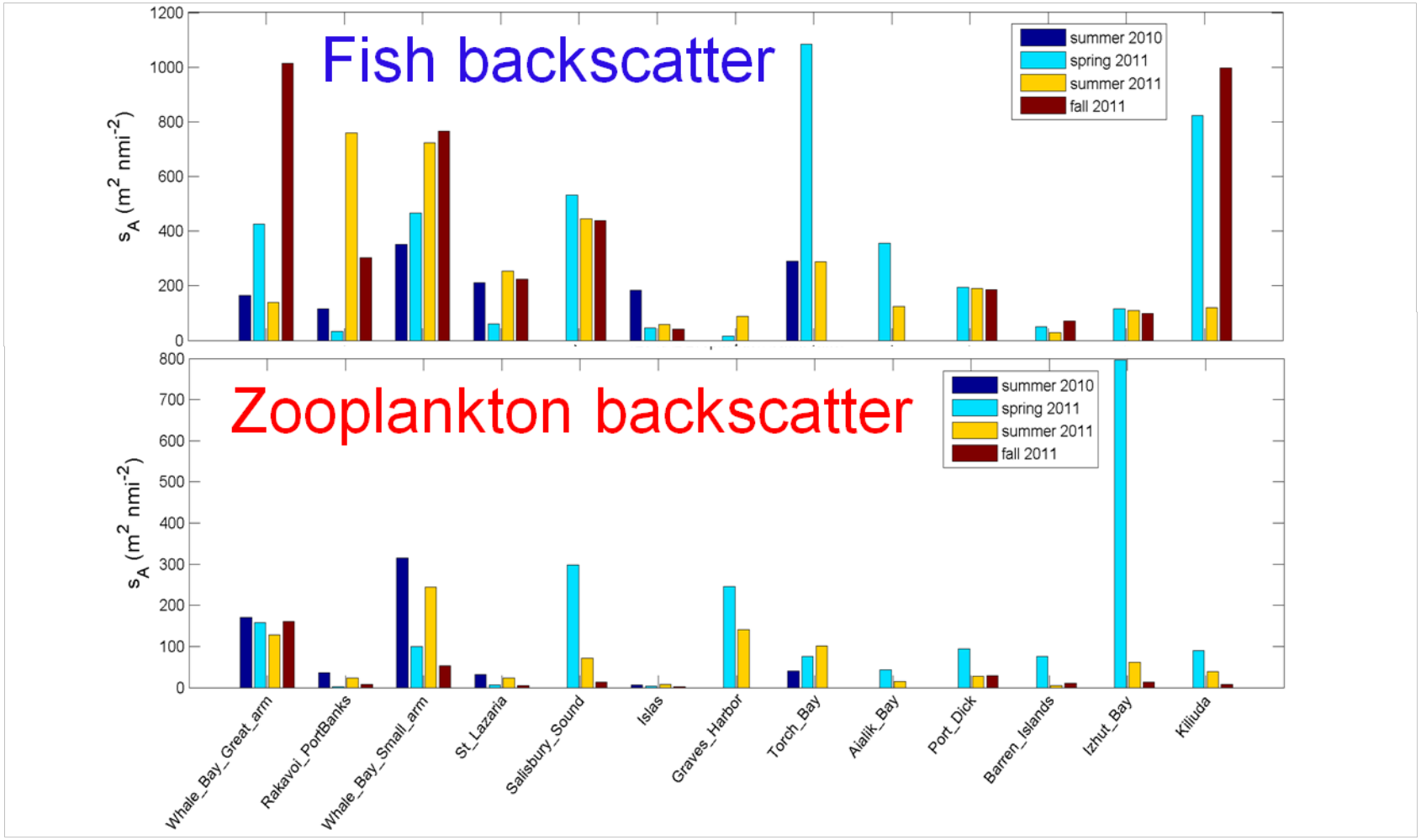

Figure 2. Preliminary results showing density of fish and zooplankton acoustic backscatter for MTL inshore sites. The X axis indicates site, and the y-axis indicates mean backscattering strength by site and season.