Cruise Report for 2006 FISHPAC Project

Prepared by: RACE Division Habitat Research Team

Cruise ID:	**FISHPAC**	Vessel(s):	***NOAA Fairweather***
Cruise Dates:	**July 31 – August 21, 2006**	Hydrographic Survey:	***H-11604***

Alaska Fisheries Science Center
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Overview

The broad scope of the Essential Fish Habitat (EFH) mandate requires an efficient process for describing and mapping the habitat needs of federally managed species. For example, research indicates surficial sediments affect the distribution and abundance of many groundfish species yet traditional sampling with grabs and cores is impractical over areas as large as the Bering Sea shelf. Acoustic tools, on the other hand, are suitable for large-scale surveying and show great promise as a substitute for direct-sampling methods, but they have not been proven for EFH purposes.

Acoustic seafloor surveys using five different sonar systems were conducted along strong gradients of groundfish abundance, as determined from many years of RACE bottom trawl survey catches at fixed stations. The value of acoustic backscatter as a habitat-defining character will be judged based on the statistical association between normalized backscatter and fish density. The benefits and costs of the different acoustical systems will be compared with data from multiple passes along the survey tracklines. Groundtruth samples of infauna, sediment, and video along each trackline will provide additional biological and geological information for the analysis.

An additional multibeam sonar survey was performed following the FISHPAC operations for an AFSC/RACE research project, described in the Appendix.

Objectives

(1) Investigate the utility of acoustic backscatter for characterizing EFH of eastern Bering Sea (EBS) species using a variety of sonar and groundtruthing systems.

(2) Determine the most cost-effective sonar methodology for large-scale mapping of EFH in the EBS.

(3) Provide hydrographic-quality bathymetry data to the NOAA Pacific Hydrographic Branch for updating nautical charts in areas with outdated or non-existent information.

Vessels and Gear

Operations were conducted aboard the NOAA Ship FAIRWEATHER, a multi-mission hydrographic survey vessel capable of continuous sonar operations.

Five different sonar systems were used to acquire acoustic backscatter in the study area. The five systems included two hull-mounted multibeam echosounders (Reson 8111-ER and 8160) on FAIRWEATHER, a high-resolution interferometric side scan sonar (Klein 5410), and a prototype long-range side scan sonar (Klein 7180 LRSSS) with an independent single beam echosounder (Elac

custom 38 kHz) (Table 1). The two Reson multibeam echosounders and the Klein 5410 side scan sonar are commercially available systems, whereas the Klein 7180 was purpose-built as part of the FISHPAC effort and was included in the group of acoustic systems because its very broad swath and high tow speed address the need for more efficient survey systems. Positions of the two towed sonars (Klein 5410, 7180) were acoustically determined with a pole-mounted Sonardyne Fusion ultra-short baseline (USBL) system interfaced to the ship's horizontal positioning sensors.

Table 1. Acoustic systems being evaluated.

	Sonar Systems				
Manufacturer	Reson	Reson	Klein	Klein	Elac
Model number	8160	8111-ER	5410	7180	custom
Configuration	Hull-mounted	Hull-mounted	Towfish	Towfish	Towfish (7180)
Frequency (kHz)	50	100	455	180	38
Bathymetry data?	Yes	Yes	Yes (interferometry)	Yes (integrated multibeam)	Yes
Backscatter data?	Yes (snippets)	Yes (snippets)	Yes (side scan)	Yes (side scan)	Yes
Imagery?	Yes	Yes	Yes	Yes	No
Maximum speed with 100% coverage	7 kts	7 kts	10 kts	7.5 kts	7.5 kts

Several state-of-the-art groundtruth instruments were used to sample the biological and geological characteristics of the seafloor (Figure 1). Sediment grabs and digital still photos were taken using the Seabed Observation and Sampling System (SEABOSS) grab sampler (http://woodshole.er.usgs.gov/operations/seaboss/seaboss.html) for the purposes of infauna and sediment characterization. Representative video footage was collected using the Towed Auto-Compensating Optical System (TACOS) system, a two-part towed camera sled recently upgraded for digital image acquisition. Both the SEABOSS and TACOS were tracked with the Sonardyne USBL system. Geophysical properties of the seafloor, as well as sound velocity within the water column, were measured using a Brooke Ocean Technology Free-Fall Cone Penetrometer (FFCPT http://www.brooke-ocean.com/ffcpt-01.html).

A triplet of optical scatter sensors (WET Labs Puck) were incorporated into the Klein 7180 towfish to continuously measure dissolved organics (red 370 nm), chlorophyll-a (green 470 nm), and total particulate concentration (blue 660 nm) in the pelagic environment. An archival light-level logger (Mk9 Wildlife Computers) supplied by Mr. Stan Kotwicki of RACE was attached to the dorsal side of a horizontal tail fin of the Klein 5410. Light level, temperature, and depth measurements were

logged at one-minute intervals. The data support his study on correlation between light intensity and groundfish distribution, while providing another potentially important environment variable for habitat research.

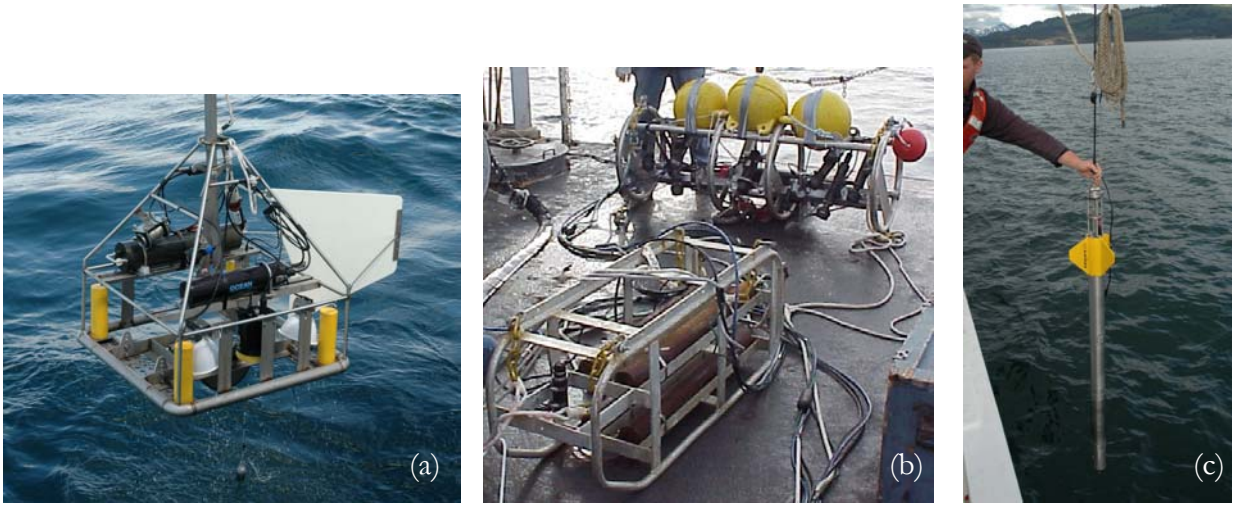

Figure 1. Groundtruthing devices used during FISHPAC cruise: (a) the SEABOSS sediment grab/camera system, (b) the TACOS towed video sled shown with clump weight and (c) the FFCPT sediment profiler.

Itinerary

13 – 17 July	Initial mobilization of AFSC equipment, Kodiak.
26 July – 5 Aug	Towed sonar system mobilization and 'shakedown' period for all sampling devices. In-port and nearshore operations, Unalaska Island region
6 – 20 Aug	Survey operations aboard NOAA Ship FAIRWEATHER, Bristol Bay region
20 – 23 Aug	Demobilization and shipping of all field gear.

Survey Design and Methods

The survey area consisted of six 140 nautical mile tracklines that traversed the southeast Bering Sea shelf over a depth range of 20 – 160 meters (Figure 2). Each trackline intersected six RACE bottom trawl survey stations and each was navigated three times with continuous shipboard operations. On every pass, backscatter and bathymetry data were collected using the ship's Reson multibeam sonars, with operator settings tuned for backscatter data. On the first pass of each line, the Klein 5410 interferometric sidescan sonar was towed at approximately 7 kts and preliminary backscatter mosaics were generated. Once the line was completed, a return trip to the start of the line was dedicated to groundtruthing and sound velocity profiling. The line was then run again in the same direction and speed as the first pass, towing the Klein 7180 LRSSS.

Groundtruth station locations were chosen following interpretation of the Klein 5410 backscatter mosaics. In heterogeneous regions along a line, only reasonably large continuous patches were sampled to minimize region-edge effects and maximize the likelihood of sampling the targeted backscatter. Trawl survey station locations were used in very broad regions of homogenous backscatter.

The hydrographic survey required sound velocity (SV) profiles every four hours. If the transit time between groundtruth stations was greater than four hours, a sound velocity cast was taken at an additional station along each line. The FFCPT was used as the primary SV instrument during FISHPAC operations. A comparison between a standard hydrographic SV profiler (CTD) confirmed the acceptability of the FFCPT for SV casts.

Three different devices were deployed at each groundtruth station. The FFCPT and SEABOSS were simultaneously deployed first. The FFCPT required instrument initialization and over-the-side acclimation prior to each series of drops on-station. Once ready, the FFCPT was allowed to free-fall with the aid of a line-pulling sheave. After penetration of the seafloor, the FFCPT was retrieved and re-deployed. Logged sensor data from the FFCPT was then downloaded over a deck cable. The SEABOSS required the power-up of the still and video camera systems, and the arming of the sediment grab prior to deployment. Camera systems were set to start shortly before bottom-contact. Using the ship's mechanical winch, the SEABOSS was lowered to the seafloor at 0.5 – 1 m/s. Once on bottom, a slow pull on the winch would ensure the lever-arm 0.1-m^2 van Veen-style grab would close properly. Two 'good' grabs were required for separate infauna and sediment samples. The infauna grab was first measured for volume and then sorted with fresh seawater on a 1 mm screen for conspicuous invertebrates and fixed in 10% buffered Formalin with Rose Bengal biological stain (later transferred to 50% isopropanol). The sediment sample was qualitatively described and shear strength stress was measured in the grab upon retrieval. The sediment grab was then cored and

stored for laboratory processing. Photographic records of the bottom were downloaded and stored in raw (*.NEF) and compressed image formats.

After stationary sampling was completed, the ship would reposition for a towed video transect across the station. The TACOS video sled and clump weight were then lowered over the stern. The desired tow speed was < 2 kts, which required careful ship positioning for either a drift or live-boat tow. Video acquisition was limited to a 15-minute duration per site to accommodate the data throughput (1.6 GB / min). Data from each camera (digital and analog) were recorded in AVI format on a dedicated workstation.

Results

Most of the scientific equipment was pre-installed during FAIRWEATHER's scheduled Kodiak in-port (13-17 July). Final mobilization in Dutch Harbor began 26 July and FAIRWEATHER departed Dutch Harbor on 5 August after completing winch repairs and local gear trials. Surveying began on the afternoon of 6 August and FAIRWEATHER returned to Dutch Harbor on the morning of 20 August. Operationally, the cruise was successful. Five complete tracklines and a small section of the sixth (i.e. 20 nm or the cell of one unique trawl station) were completed during the course of the cruise using all sonar systems (Figure 2). Multiple towed and on-station instruments were safely deployed/retrieved by the scientists and crew. Large volumes of data and many groundtruth samples were obtained (Table 2). Data for each device were acquired and securely archived on redundant data drives and tapes. Collaborative processing and analysis of data for EFH, nautical charting, and other technical purposes will be undertaken by research partners on the FAIRWEATHER, in the RACE and REFM Divisions, at the NOAA Pacific Hydrographic Branch, and at the University of New Hampshire Center for Coastal and Ocean Mapping (see Scientific Personnel).

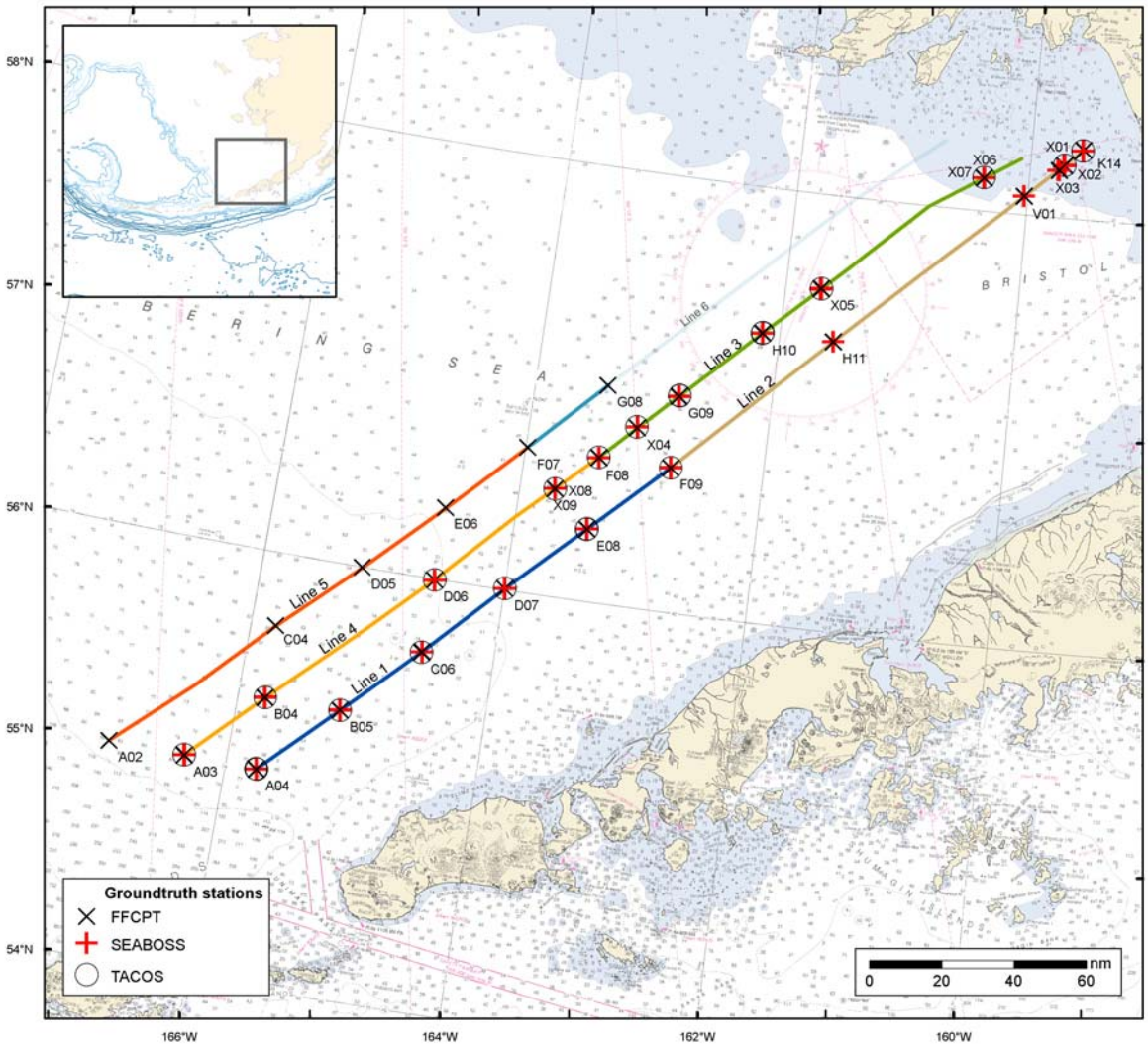

Figure 2. Map of FISHPAC completed tracklines and groundtruth sample locations.

Table 2. Data collected during the 2006 FISHPAC survey.

Instrument	Total sampling units
Klein 7180 sidescan	720 nm
Klein 5410 sidescan	720 nm
Reson 8160 multibeam	2,000 nm
Reson 8111-ER multibeam	2,000 nm
SEABOSS grab infauna	25 samples
SEABOSS grab sediment	25 samples
SEABOSS still photos	~ 100 JPG/RAW
TACOS digital video	18 stations
TACOS analog video	18 stations
FFCPT (geophysical)	27 stations
FFCPT (sound velocity)	35 stations

Scientific Personnel

AFSC RACE, Seattle, WA
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Appendix. Akta Mackerel Spawning Area

Additional sonar survey work was performed for the AFSC by NOAA Ship FAIRWEATHER following the debarkation of scientific personnel and gear. The survey site is a known Atka mackerel spawning area under investigation by other RACE scientists (contact: Bob Lauth; Figure 3). Bathymetry and backscatter data were collected using the hull-mounted Reson 8111-ER multibeam system following standard operating procedures of the FAIRWEATHER. Data will be delivered to the Pacific Hydrographic Branch (PHB), and then processed collaboratively by both PHB and RACE scientists.

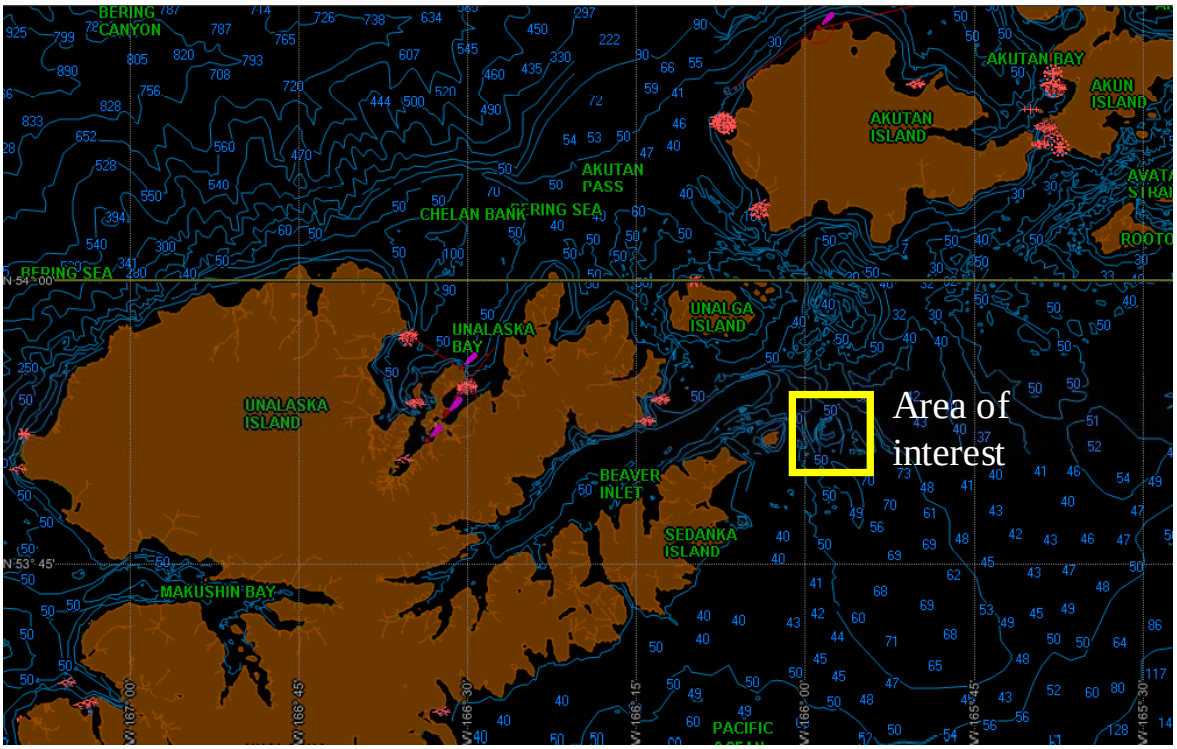

Figure 3. Map of Atka mackerel spawning area, surveyed by FAIRWEATHER following FISHPAC operations.