Cruise Report for 2008 FISHPAC Project

Prepared by: RACE Division Habitat Research Team

<table>
<thead>
<tr>
<th>Cruise ID:</th>
<th>FISHPAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel:</td>
<td>NOAA Ship Fairweather</td>
</tr>
<tr>
<td>Cruise Dates:</td>
<td>July 21 – August 10, 2008</td>
</tr>
<tr>
<td>Hydrographic Survey:</td>
<td>H-11906</td>
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</table>

Alaska Fisheries Science Center
7600 Sand Point Way NE
Seattle, WA 98115-6349

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Background

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 are suitable for large-scale surveying and show great promise as a substitute for direct-sampling methods, but they have not been proven useful for EFH purposes.

The 2008 cruise continued research begun in 2006. Acoustic seafloor surveys using 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. Ultimately, 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 acoustic systems will be compared with data from multiple passes along the survey tracklines. Sediment samples, video and infauna collected along each trackline will provide additional biological and geological information for the analyses.

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bathymetry data to the NOAA Pacific Hydrographic Branch for updating nautical charts in areas with outdated or non-existent information.

Vessel 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 utilized to acquire acoustic backscatter in the study area. The five systems included two hull-mounted multibeam echosounders (Reson 8111-ER and 8160), a towed high-resolution interferometric side scan sonar (Klein 5410), and a towed 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 LRSSS was purpose-built as part of the FISHPAC effort and was included in the group of acoustic systems because its very broad swath and relatively high tow speed address the need for more efficient survey systems to accomplish large-scale EFH mapping. Positions of the two towed sonars (Klein 5410, 7180 LRSSS) were acoustically determined with a pole-mounted Sonardyne Fusion ultra-short baseline (USBL) that was calibrated and interfaced to the ship’s horizontal positioning sensors. This method of positioning was used through the first part of the cruise (67 nmi) until a structural failure of the mounting pole occurred. Thereafter, positions were determined using cable out and a layback algorithm. It should be noted, however, that post-processing analysis determined the layback calculations were within meters of the USBL-determined positions in the along-track direction and within 10 m in the across-track direction.

Table 1. Acoustic systems being evaluated.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Reson</th>
<th>Reson</th>
<th>Klein</th>
<th>Klein</th>
<th>Elac</th>
</tr>
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<tbody>
<tr>
<td>Model number</td>
<td>8160</td>
<td>8111-ER</td>
<td>5410</td>
<td>7180</td>
<td>custom</td>
</tr>
<tr>
<td>Configuration</td>
<td>Hull-mounted</td>
<td>Hull-mounted</td>
<td>Towfish</td>
<td>Towfish</td>
<td>Towfish (7180)</td>
</tr>
<tr>
<td>Frequency (kHz)</td>
<td>50</td>
<td>100</td>
<td>455</td>
<td>180</td>
<td>38</td>
</tr>
<tr>
<td>Bathymetry data?</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes (integrated)</td>
<td>Yes</td>
</tr>
<tr>
<td>Backscatter data?</td>
<td>Yes (snippets)</td>
<td>Yes (snippets)</td>
<td>Yes (side scan)</td>
<td>Yes (side scan)</td>
<td>Yes (single beam)</td>
</tr>
<tr>
<td>Imagery?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Maximum speed with 100%</td>
<td>7 kts</td>
<td>7 kts</td>
<td>10 kts</td>
<td>7.5 kts</td>
<td>7.5 kts</td>
</tr>
</tbody>
</table>

Three state-of-the-art ground-truth instruments were used to sample and verify 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) for the purposes of infauna and sediment characterization. Representative video footage was collected using the Towed Auto-Compensating Optical System (TACOS), a two-part towed camera sled recently upgraded for higher-quality digital image acquisition. As with the two towed sonars, both the SEABOSS and TACOS were tracked with the Sonardyne USBL system. Geophysical properties of the seafloor and sound velocities within the water column were measured using a Brooke Ocean Technology Free-Fall Cone Penetrometer (FFCPT).
A triplet of optical scatter sensors (WET Labs ECO-Triplet Puck) was incorporated into the Klein 7180 LRSSS 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.

Figure 1. Ground-truthing 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.

**Cruise Plan**

**Original itinerary**

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activity Description</th>
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<tbody>
<tr>
<td>5 – 8 July</td>
<td>Initial mobilization of AFSC equipment, Homer, AK.</td>
</tr>
<tr>
<td>21 July – 23 July</td>
<td>Towed sonar system mobilization, pre-project meetings, and ‘shakedown’ period for all sampling devices. In-port and nearshore operations, Unalaska Island, AK region</td>
</tr>
<tr>
<td>23 July – 9 Aug</td>
<td>Survey operations aboard NOAA Ship <em>Fairweather</em>, Bristol Bay region</td>
</tr>
<tr>
<td>10 Aug</td>
<td>Demobilization and shipping of all field gear.</td>
</tr>
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</table>
Original Survey Design and Methods

The survey area consists of six 140-155 nmi tracklines that traverse the southeast Bering Sea shelf over a depth range of 20 – 180 meters (Figure 2). The tracklines intersect RACE bottom trawl survey stations (i.e. waypoints) and are to be navigated three times with continuous shipboard operations. Backscatter and bathymetry data will be collected continuously using the ship’s Reson multibeam sonars with operator settings tuned for backscatter data (i.e. no adjustments to power, pulse length or gain). The Klein 5410 interferometric side scan sonar will be towed at 7 kts on the first pass, and the return pass dedicated to groundtruthing at several points along the line. The third pass will use the Klein 7180 LRSSS towed at approximately 7 kts. Preliminary backscatter mosaics will then be generated. Sound velocity profiling will be performed with the FFCPT or Seacat SBE 19+ Profiler at least every four hours, in keeping with NOAA hydrographic standards.

Figure 2. FISHPAC 2008 tracklines. Blue and red colors represent separate lines. Overlaid on NOAA chart 16011.
Ground-truth station locations will be chosen following interpretation of the Klein 5410 backscatter mosaics. In heterogeneous regions along a line, only reasonably large continuous patches will be sampled to minimize region-edge effects and maximize the likelihood of sampling the targeted backscatter.

The FFCPT, SEABOSS, and TACOS will be deployed for ground truthing purposes. The FFCPT requires instrument initialization and over-the-side acclimation prior to each series of drops on-station. Once ready, the FFCPT will free-fall with the aid of a line-pulling sheave. After penetration of the seafloor, the FFCPT will be retrieved and re-deployed for multiple drops at each station. Sensor data from the FFCPT will be sent real-time to the survey plotting room and logged. The SEABOSS requires the power-up of the still and video camera systems, and the arming of the sediment grab prior to deployment. Camera systems will be set to start shortly before bottom-contact. Using the ship’s mechanical winch, the SEABOSS will be lowered to the seafloor at 0.5 – 1 m/s. Once on bottom, a slow pull on the winch will ensure the lever-arm 0.1-m² van Veen-style grab will close properly. Two grabs will be done for separate infauna and sediment samples. The infauna grab will be 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 will be qualitatively described in the grab upon retrieval. Two sediment subsamples, one for granulometric characterization and one frozen for biogeochemical analysis (TOC, TN/TP, chl-a), will then be stored for laboratory processing. Photographic records of the bottom will be downloaded and stored in both raw (*.nef) and compressed (*.jpg) image formats. After stationary sampling is completed, the ship will reposition for a towed video transect across the station. The TACOS video sled and clump weight will then be lowered over the stern. The desired tow speed is < 2 kts, which requires careful ship positioning for either a drift or live-boat tow. Video acquisition will be limited to a 15-minute duration per site to accommodate the high data throughput (1.6 GB / min). Data from the digital and analog cameras will be recorded in AVI format on a dedicated workstation.

**Ad Hoc Field Activities**

The FISHPAC project was significantly shortened due to late arrival of the vessel, inadequate staffing in the vessel’s engineering department, and volcanic activity. The vessel spent considerable time alongside in Dutch Harbor between 21 July and 7 August with several day trips and nearshore anchorages during this period. These opportunities were used for equipment shakedown and local sea trials. The actual schedule and activities during the pre-cruise period (21 July to 7 August) and the Bristol Bay cruise (8-10 August) are summarized below.
Actual Itinerary

5 – 8 July  Initial mobilization of AFSC equipment, Homer AK.

24 July – 7 Aug  Towed sonar systems mobilization, pre-project meetings, and ‘shakedown’ period for all sampling devices. In-port and nearshore day-trip operations, Unalaska Island region

8 – 10 Aug  Survey operations aboard NOAA Ship *Fairweather*, Bristol Bay region

10 Aug  Demobilization and shipping of all field gear.

Pre-Cruise Activities


25 July  In port. Scientific party embarks, safety briefing, delivery MVP winch cable. Team meeting on the *Fairweather* staffing issue, multibeam backscatter acquisition protocol meeting, equipment calibration, review gear handling with crew. Final integration of ship’s sensors into project’s navigation system including helmsman display for real-time positioning of towed instruments. Completed hardware and software upgrades to the MVP and FFCPT systems, enabling real-time telemetry and storage of sound velocity profiles and seabed geophysical characteristics. Overboard LRSSS testing. USBL static calibration. General deck preparations.

26 July  USBL dynamic calibration with the COMPATT transponder and Ranger software. Verify simultaneous operation of Reson 8111 and 8160 for backscatter and bathymetry. Develop protocols and prove capability for underway sound velocity and seabed sampling with the FFCPT at 6 kts. Return to dock.

27 July  In port. Vessel repairs, general pre-cruise preparations and planning.

28 July  In port. Review vessel mobilization process. Project briefing to officers of USCGC *Jarvis*. 
29 July  Underway testing Klein 7180 LRSSS and Klein 5410 side scan sonars with simultaneous multibeam acquisition (both Resons), encountered Position Approximate (PA) wreck. Compare omni-directional and directional USBL transponder performance. Volcano alert. SEABOSS test at anchor. Habitat science presentation to *Fairweather* officers and crew.

30 July  Underway testing Klein 7180 LRSSS and Klein 5410 side scan sonars with simultaneous multibeam acquisition. Installed and tested new hardware and software in TACOS, providing increased light-sensitivity and higher resolution imagery. Return to dock.

31 July – 3 August  In port. General preparations and meetings. Vessel staffing issue unresolved - develop alternative cruise scenarios.

4 August  Continue equipment testing (FFCPT/7180 LRSSS/5410/USBL). Survey potentially active hydrothermal feature with Klein 5410. Finalized safe deployment protocols and proved capability for simultaneously towing a side scan sonar and the FFCPT (for sound velocity profiling and seabed sampling). Anchor Unalaska Bay.

5 August  In port.

6 August  Multibeam survey of potentially active hydrothermal features. Anchor.

7 August  Replacement 2nd assistant marine engineer embarks. Ship departs for Bristol Bay survey line 5. Klein 7180 LRSSS reconnaissance survey during transit to operations area.

**Bristol Bay Cruise Activities**

Survey time for the 2008 FISHPAC project was reduced from 18 to 2 days at sea. Ultimately, one pass was completed of line 5 with the Klein 5410 side scan sonar and the ship’s Reson 8111 and 8160 sonars, rather than three passes on each of the six transects as originally planned (Figure 2). Survey line 5 (Figure 3) was chosen for several reasons:

1. It was feasible to reach the line and conduct the survey one time in one direction in the available time;

2. Only partial Klein 7180 LRSSS coverage was obtained in 2006; and
3. Inclement weather in 2006 caused generally low-quality data from the Klein 5410, inoperable multibeam echosounders, and prevented infauna sampling.

Figure 3. The transect and two transit lines completed during FISHPAC 2008 are shown in red. (Lines with arrows indicate the operational sequence.) Symbols mark the locations for the three groundtruth stations sampled. The line-5 transect covered depths from 160-70 m (southwest to northeast), while the transit lines to and from line 5 covered depth ranges of 80-1300 m and 80-700 m, respectively. Overlaid on NOAA chart 16011.
Additionally, reconnaissance backscatter and transmissiometer data were collected with the Klein 7180 LRSSS during the two transits between Dutch Harbor, AK and the transect line (180 nmi total). Both of the ship’s Reson systems continuously collected bathymetry and backscatter data during the transits, with minimal operator adjustments to favor backscatter data quality.

A free-fall cone penetrometer (FFCPT) collected geophysical data and sound velocity profiles at 2-hour intervals while underway, and also at selected ground-truthing stations along the survey line. After a failure in the FFCPT cable jacket, traditional CTD deployments were performed at 4 hour intervals. Paired infauna and sediment benthic grab samples were collected at three different locations (a single sample at the final station was used for both purposes). The samples were described, processed and stored for laboratory analysis. Photographic records of the bottom taken by SEABOSS were downloaded and stored in raw (*.nef) and compressed image (*.jpg) formats.

The full benthic habitat survey with sonar systems and accompanying groundtruthing activities is being rescheduled.

**Major Accomplishments**

Most of the scientific equipment was pre-installed during the *Fairweather*’s scheduled Homer in-port (5-8 July). Final mobilization in Dutch Harbor began 21 July and the *Fairweather* departed Dutch Harbor on 7 August after reaching minimum staffing level for the engineering department, completing winch repairs, and conducting useful local gear trials. Surveying began on 8 August and the *Fairweather* returned to Dutch Harbor on the morning of 10 August. Operationally, the cruise was extremely short and therefore had limited success. One line of six was completed in one direction due to a total sailing time of ~50 hours. Nonetheless, there were a number of significant accomplishments. In addition to those listed in the detailed pre-cruise itinerary, the FISHPAC team:

1. Established the capability to simultaneously survey and ground truth by deploying both side-scan sonar and the FFCPT to collect seabed backscatter, sound velocity profiles and geophysical properties of sediment while underway at 6 kts.

2. Collected quality side scan sonar data with Klein 5410 on survey line 5. In the 140 nmi surveyed, 14 sites were determined to be worthy of revisiting for sonogram verification. Sixty unusual mounds, 73 unidentified hard returns, two regions of odd texture, 10 distinct sediment patches, 92 trawl marks, and one spire-like object were visible in the imagery (Figure 4);

3. Conducted multibeam and side scan sonar surveys at potentially active hydrothermal features near the port of Dutch Harbor;
4. Collected new infauna samples as part of a continuing project to characterize these communities in the EBS;

5. Collected continuous dissolved organics (red 370 nm), chlorophyll-a (green 470 nm), and total particulate concentration (blue 660 nm) data from the pelagic environment along two cross-shelf transects totaling 180 nmi;

6. More than 1500 still images and approximately 15 hours of video, including 4.3 hours from the ship's deck camera, were recorded for development of various training and outreach products;

7. Acquired hydrographic-quality bathymetry data for updating NOAA nautical charts of an area with outdated or non-existent information; and thus


![Image of mound-like objects in processed Klein 5410 imagery.](image)

**Figure 4.** Examples of mound-like objects in the processed Klein 5410 imagery.
Data for each device were acquired and securely archived on redundant data drives (Table 2). Collaborative processing and analysis of data for EFH characterization, 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).

Table 2. Data collected during the 2008 FISHPAC survey.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Total sampling units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klein 7180 LRSSS side scan</td>
<td>180 nmi</td>
</tr>
<tr>
<td>Klein 5410 side scan</td>
<td>140 nmi</td>
</tr>
<tr>
<td>Reson 8160 multibeam</td>
<td>360 nmi</td>
</tr>
<tr>
<td>Reson 8111-ER multibeam</td>
<td>350 nmi</td>
</tr>
<tr>
<td>SEABOSS grab (infauna)</td>
<td>3 samples</td>
</tr>
<tr>
<td>SEABOSS grab (sediment)</td>
<td>3 samples</td>
</tr>
<tr>
<td>SEABOSS still photos</td>
<td>13 JPG, 13 NEF</td>
</tr>
<tr>
<td>FFCPT (geophysical)</td>
<td>10 drops</td>
</tr>
<tr>
<td>FFCPT (sound velocity)</td>
<td>10 drops</td>
</tr>
<tr>
<td>CTD (sound velocity)</td>
<td>9 drops</td>
</tr>
</tbody>
</table>

**Scientific Personnel**

**AFSC RACE, Seattle, WA**  
Dr. Bob McConnaughey – Chief Scientist  
Dr. Cynthia Yeung – Co-PI  
Steve Intelmann  
Lt. John Lomnicky  
Lt JG Meghan McGovern  
Karna McKinney  
Keith Smith  
Dr. Steve Syrjala
Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, NH
Dr. Lloyd Huff – Team Leader
Glenn McGillicuddy
Brian O’Donnell

US Navy, Naval Undersea Warfare Center, Keyport, WA
Mike Farnam – Team Leader
Mark Moody
Ed Draper
Gunnar Forsman
Jim Hosford

L3 Communications, Klein Associates, Inc.
Steve Ciambrone – Team Leader
Ricardo Hassan
Dave Winslow

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For further information, contact Russ Nelson, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE, Seattle, WA 98115-6349. Telephone (206) 526-4170.