U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES
Pacific Islands Fisheries Science Center
2570 Dole St. • Honolulu, Hawaii 96822-2396
(808) 983-5300 • Fax: (808) 983-2902

CRUISE REPORT[1]

VESSEL:	NOAA Ship *Oscar Elton Sette*, Cruise SE-12-08
PROJECT PERIOD:	September 22–October 3, 2012
AREA OF OPERATION:	Leeward Maui
TYPE OF OPERATION:	Comparison of Fishery-Independent Sampling Methods for Hawai‘i Bottomfish

ITINERARY:

22 September	Embarked science party. Departed Ford Island and swung *Oscar Elton Sette* compass. Proceeded to Olowalu, Maui for EK60 calibration.
23 September	Conducted EK60 calibration off Olowalu, Maui. Conducted BRUVS operations along leeward Maui.
24 September-2 October	Conducted EK60 and TOAD operations in survey area “D” north of Kahoolawe. Conducted BRUVS operations along leeward Maui and windward Lanai. Conducted personnel transfers as necessary.
3 October	Arrived Pearl Harbor. Disembarked science party. End of project.

.

[1] PIFSC Cruise Report CR-12-009
Issued 30 October 2012

A. Mission Overview

. This mission, led by Dr. Benjamin L. Richards of the Pacific Islands Fisheries Science Center (PIFSC) was designed to cross-compare fishery-independent methodologies for sampling Hawaiʻi Deep 7 bottomfish assemblages. Post-mission data analyses were carried out in collaboration with Drs. Jerald Ault and Steve Smith of the University of Miami, Rosenstiel School of Marine and Atmospheric Science, Dr. Jeff Drazen of the University of Hawaiʻi – Mānoa, as well as Dr. Euan Harvey of the University of Western Australia to quantify the power of the data generated by each method and to make comparisons among methods. Strengths and weaknesses will be outlined and the usability of each method for stock assessment will be discussed. A cost/benefit analysis will also be conducted.

Each member of the scientific party and the crew and officers of the NOAA Ship *Oscar Elton Sette*, the SeaEngineering R/V *Huki Pono*, and the PIFG cooperative fishing vessels *Naomi K*, *Imua*, and *Hokuloa* performed their required duties exceptionally and should be commended. Significant logistical and scientific challenges were encountered throughout the mission, and each member of the team rose to the occasion.

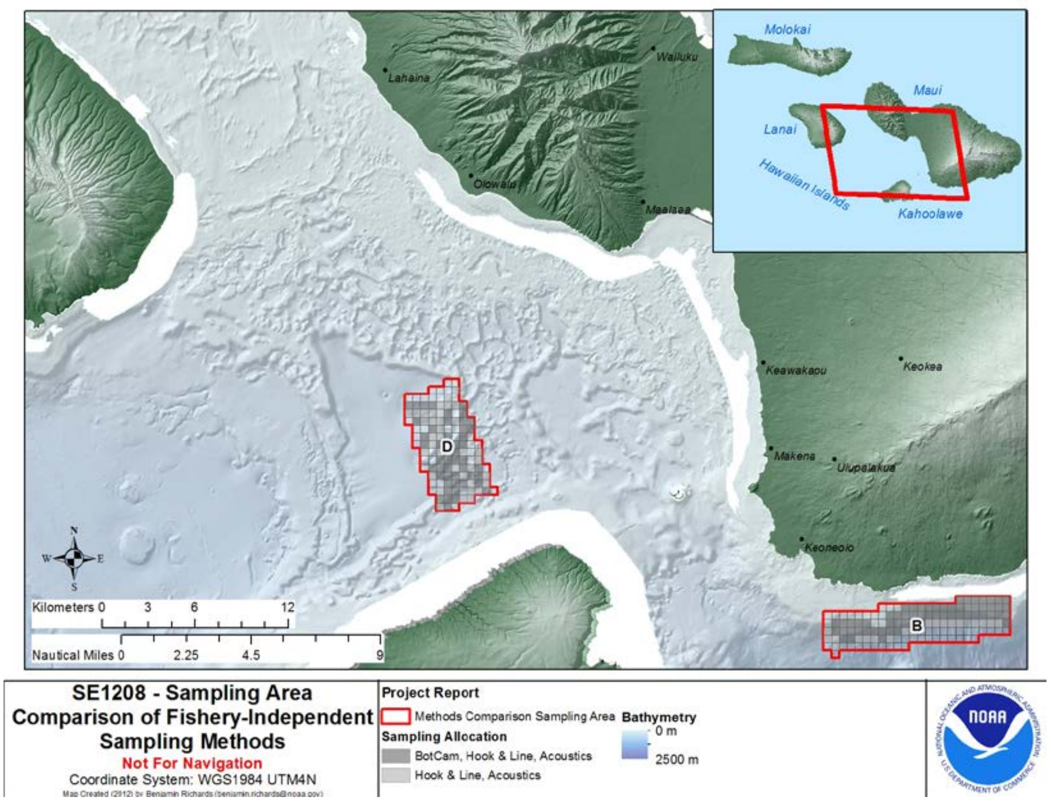

Figure 1.—SE-12-08 Sampling Area. Due to weather conditions, the majority of sampling took place in survey area “D” with some BotCam and Hook & Line sampling in “B”. BRUVS operations were conducted along leeward Maui and eastern Lanai.

B. The scientific objectives of the cruise were:

. Research and development of methods to cross-compare or calibrate fishery dependent (extractive) and fishery-independent (non-extractive) sampling methodologies for use in stock assessment.

. Estimate deepwater reef fish (i.e., mesophotic) or bottomfish abundance using a variety of extractive and non-extractive methods (Figs. 2 and 3) including

  a. EK60 Active acoustics

  b. Baited underwater video camera system (BotCam)(R/V *Huki Pono*)

  c. Cooperative fishing vessels (Pacific Islands Fisheries Group [PIFG])

  d. Bio-Sampling of Deep 7 Bottomfish species

  e. TOAD camera

  f. Shallow-water baited/unbaited underwater video camera system (BRUVS)

C. Methods and Results

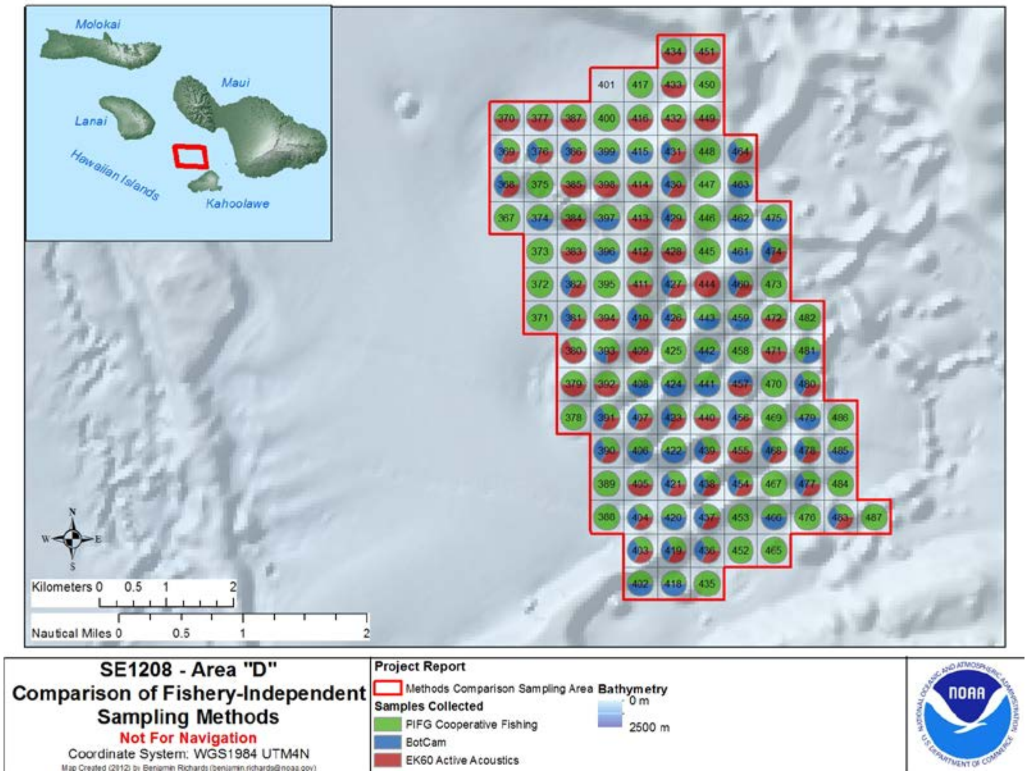

Figure 2.--A map of sampling area "D" showing the distribution of sampling gears by grid cell (e.g., PIFG Cooperative Fishing, BotCam Operations, and EK60 Active Acoustics). Colored circles indicate only that the grid cell was sampled. The size of the circle does not correlate with abundance or biomass data.

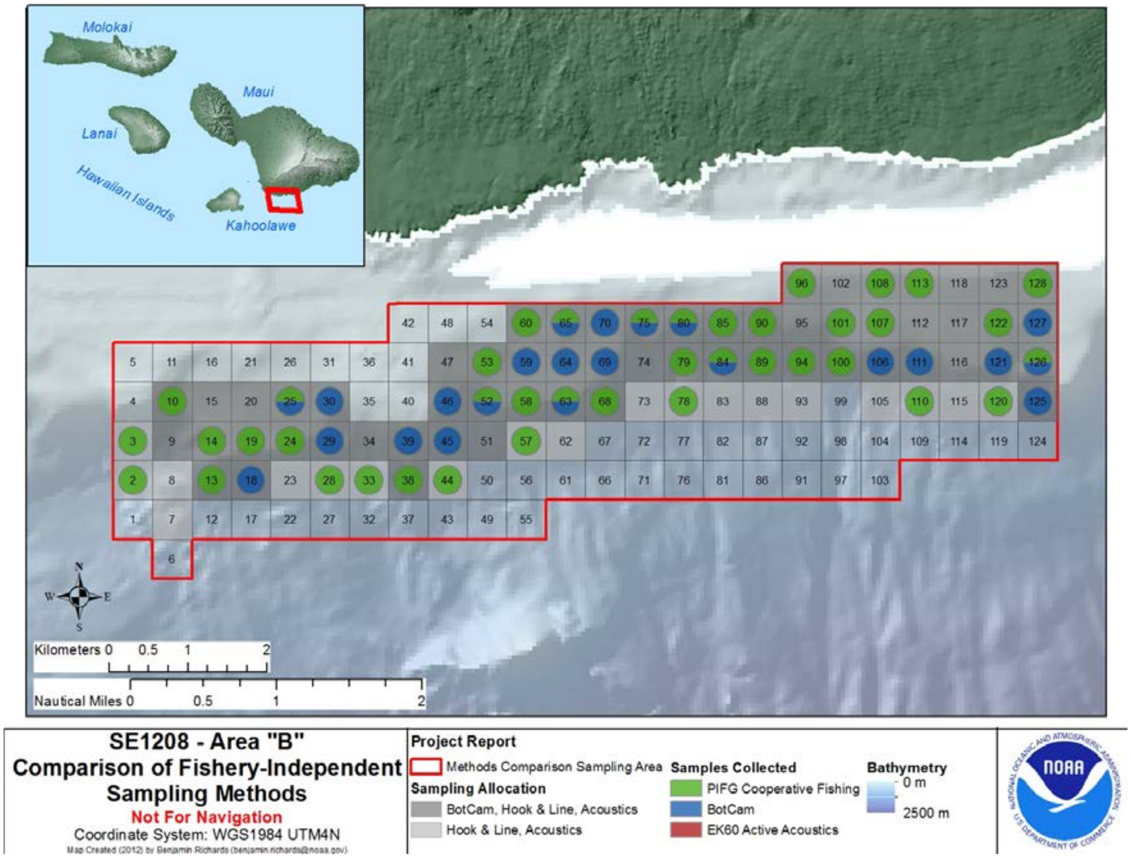

Figure 3.--A map of sampling area “B” showing the distribution of sampling gears by grid cell (e.g., PIFG Cooperative Fishing and BotCam Operations). Colored circles indicate only that the grid cell was sampled. The size of the circle does not correlate with abundance or biomass data. EK60 Acoustic data were not collected in area “B”.

EK60 Active Acoustics (NOAA Ship *Oscar Elton Sette*)

The first objective of the EK60 Active Acoustic operation was to identify a new calibration site as the previous calibration site at Kealakekua Bay on the Big Islands of Hawai‘i is inconvenient for projects centered in the Maui area and is no longer available due to new regulations. A new calibration site has been successfully identified and tested west of Olowalu, Maui in 23 fathoms (43 meters) water depth at (20° 49.057’N x 156° 39.107’W) (Fig. 4).

A successful swing calibration of the 38, 70, and 120 kHz transducers was performed using Simrad's LOBES program and conductivity-temperature-depth (CTD) data from the calibration site. Following the successful calibration, EK60 acoustic transects were conducted within and adjacent to survey area “D”. Transducer settings were updated with the calibration values, and sound speed was updated with the value from a CTD performed at the study site.

Two types of surveys were conducted: single-pass and multi-pass. Single-pass surveys were designed to achieve maximum coverage across the survey area and to quickly quantify the acoustic field of each grid cell. Typically, three grid cells were surveyed in a single pass, but additional grid cells were often sampled, especially when transiting between multi-pass surveys. Multi-pass surveys were designed to quantify short-term variability within a grid cell to determine how many acoustics passes are necessary to adequately quantify a typical grid cell. Multi-pass surveys were accomplished by maxing six EK60 acoustic passes through a single grid cell in quick succession. Three north-south passes were made followed by three east-west passes. For a subset of these surveys, simultaneous acoustic and stereo-video camera data were collected using either the TOAD camera device or a CTD frame (both discussed later) to groundtruth the acoustic data.

During the cruise, 13 single-pass acoustic surveys were conducted across 62 cells, approximately 31 km total (Fig. 5). In addition, 13 multi-pass surveys were conducted within individual cells (6 x 13) to determine temporal variability and establish an acceptable minimum survey time for future surveys. Seven surveys were conducted in combination with the tethered optical assessment device (TOAD) camera sled, and five were conducted while using stereo-video cameras attached to the CTD frame. Two of the CTD video-camera efforts were successful in placing the cameras in an aggregation; however, preliminary results from other CTD and all TOAD operations were not successful in targeting aggregations visible on the acoustic instruments. This was due, in some cases, to the fish identified in the acoustics being too deep to be resolved by the cameras (> 250 m) or to the imprecise positioning of the ship with respect to the schools.

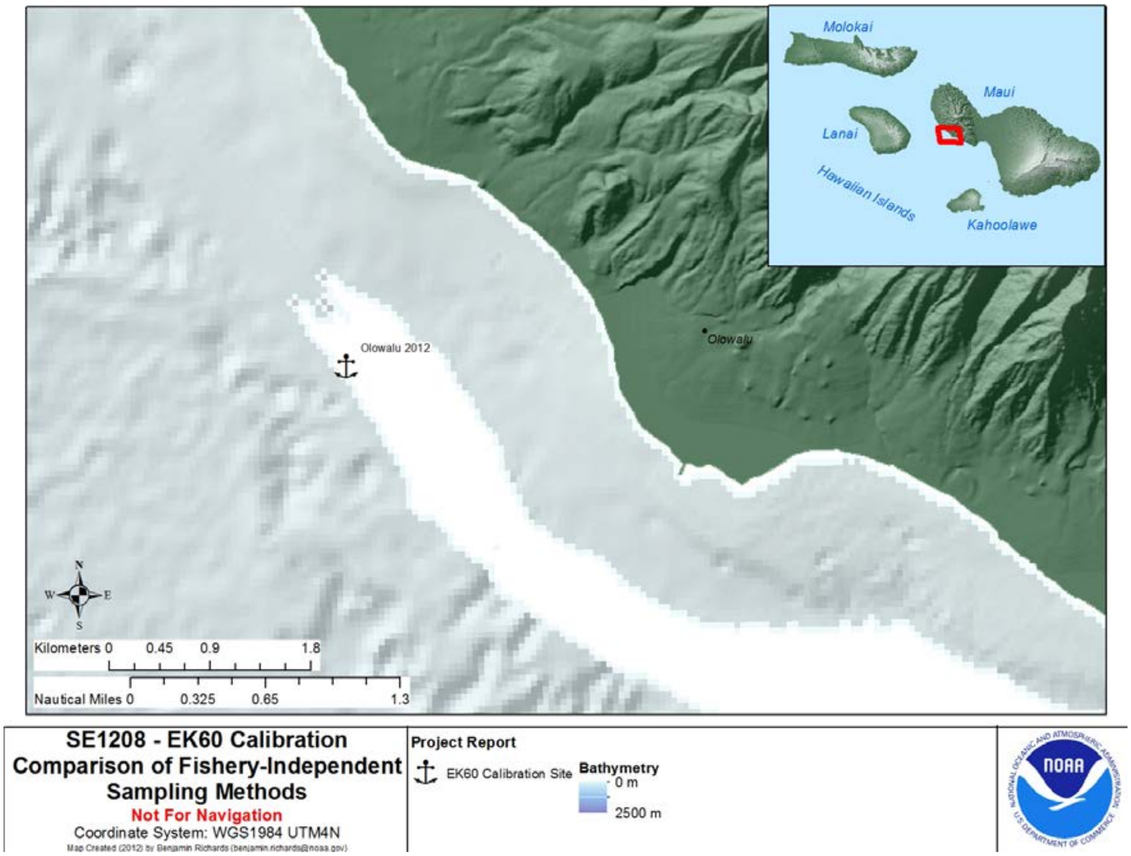

Figure 4.--A map showing the successful EK60 calibration site located during SE-12-08. This area provided good holding and light winds in the lee of the west Maui mountains. Water depth was 23 fathoms (43 meters) and was outside of all designated spinner dolphin resting habitat. The coordinates for the location are 20° 49.057'N x 156° 39.107'W.

Three simultaneous acoustic and fishing operations were also conducted at areas with acoustically observed high densities of fish. The size and weight of 15 bottomfish caught during these operations will be compared to the acoustic signatures.

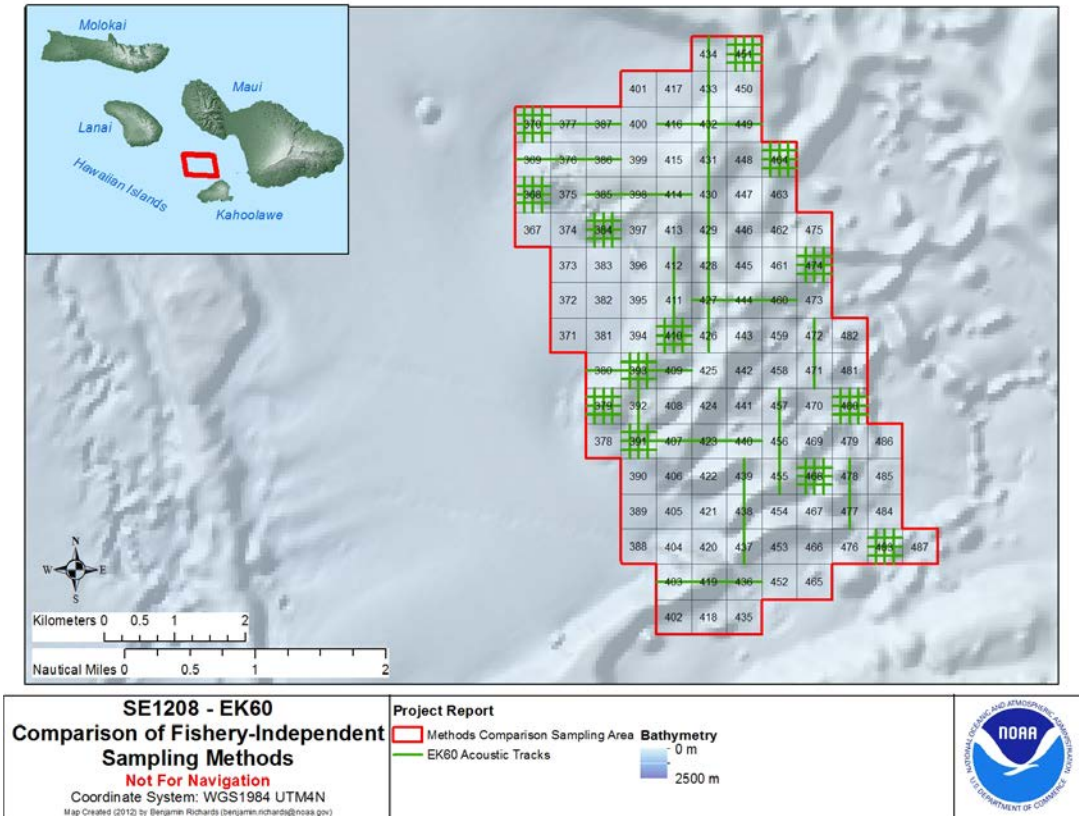

Figure 5.--A map showing EK60 Active Acoustic transects conducted during SE-12-08. Grid cells were sampled using both single and multiple passes. Multiple passes were conducted immediately after one another, three running north to south and three east to west. These multiple passes were considered replicates and will be used to assess variability with the grid cell and, therefore, how many replicates are necessary to adequately characterize a typical grid cell.

BotCam Operations (RV *Huki Pono*)

BotCam sampling was conducted from the RV *Huki Pono* by staff from the lab of Dr. Jeffrey Drazen at the University of Hawai'i-Mānoa. Four BotCam units were used, each equipped with stereo ROS Navigator cameras, SBE 39 CTDs, DataToys DVRs, CART acoustic releases, bait arm/light sync and a single unit with Nortek Aquadopp current meter (Fig, 6). Each unit is suspended off the bottom approximately 3 m and was tethered to surface buoys. Technical difficulties reduced the sampling to 3 functional units. Each deployment was baited using a 50/50 mix of ground anchovies and squid. Each deployment recorded video for 45 min and then was retrieved and redeployed.

There were a total of 29 deployments in survey area "B". One deployment failed to record and one deployment recorded partial video (25 min). Three deployments recorded full videos on only a single camera. Wind and sea conditions forced us to terminate operations after 2 days of sampling. Sampling was relocated to survey area "D" where a total of 61 deployments were made in 6 days. One deployment failed and was repeated with success. All 48 grids designated for BotCam, Hook/Line, and Acoustics were completed. An additional 12 grids designated for Hook/Line and Acoustics were sampled. This included grid #393, which had shown aggregations of interest in EK60 surveys.

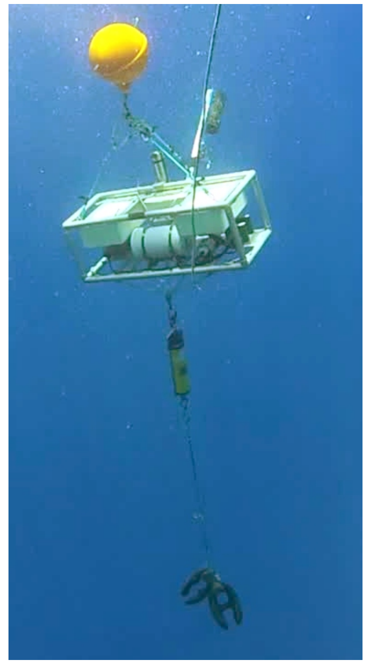

Figure 6.--A BotCam descends from the RV *Huki Pono* during SE-12-08.

Two days of scientist exchanges between the *Sette* and RV *Huki Pono* allowed for observation of BotCam techniques.

Coordination between the fishing vessels and Sette allowed for relative ease of sampling our designated grids. Thanks to the crew of the "Steel Toe" for gear, personnel, and supply exchanges.

PIFG Cooperative Fishing Operations (PIFG Cooperative Fishing Vessels)

Cooperative fishing operations were conducted by three charter vessels under the direction of the Pacific Islands Fisheries Group (PIFG). These three vessels, *Naomi K*, *Imua*, and *Hokuloa*, were randomly assigned to grid cells within each of the survey areas. Within each grid cell, each vessel conducted two 15-min drift with hook and line, simulating normal commercial bottomfishing methods. Fishing methods were standardized among vessel with each vessel fishing two bottom lines with 4 hooks on each line. Hooks were #10 size and were attached to the down-line with 1-meter leaders. One line was baited with squid while the other was baited with anchovy. Over the course of SE-12-08, PIFG fishing vessels sampled a total of 146 grid cells, 40 in survey area "B" and 106 in survey area "D".

Bio-Sampling (NOAA Ship *Oscar Elton Sette*)

The life history program (LHP) has been in collaboration with commercial fishermen and the Pacific Islands Fisheries Group (PIFG) to collect valuable "Deep 7" bottomfish specimens for age and growth research and size and age at maturity studies. Fishermen associated with PIFG voluntarily donate fish of rarely encountered sizes, coordinate with life history staff to biosample their catch before being sold, and occasionally provide heads and gonads of various bottomfish specimens. The bottomfish of interest include six snappers and one grouper: Ehu (*Etelis carbunculus*), Onaga (*Etelis coruscans*), Opakapaka (*Pristipomoides filamentosus*), Kale kale (*Pristipomoides sieboldii*), Gindai (*Pristipomoides zonatus*), Lehi (*Aphareus rutilans*), and Hapuupuu (*Hyporthodus quernus*). During research project SE-12-08, PIFG cooperative fishing vessels provided fish caught during the fishery-independent grid surveys for biosampling (Fig. 7). Fisheries Associate, Meagan Sundberg, received and processed all specimens caught by the three participating fishing vessels throughout the entirety of the cruise. Additional samples were obtained from fish caught by scientists bottomfishing from the *Sette* after daytime operations were completed. Length and weight measurements were obtained; otoliths and gonads were extracted, labeled, and preserved; and intact stomachs were saved from each of the 80 fish obtained. The otolith is a fundamental structure used to determine age. Age from collected fish will be determined either by counting daily and annual growth rings or by utilizing a recently developed technology using bomb radiocarbon dating techniques. A cross-section of the gonads collected will be used to create histological slides. Maturation state and specific reproductive status can be determined by analyzing these slides and will be used to estimate fecundity or spawning frequency. Each fishing vessel had an observer onboard to record location, drift and reel information, weather conditions, and species caught.

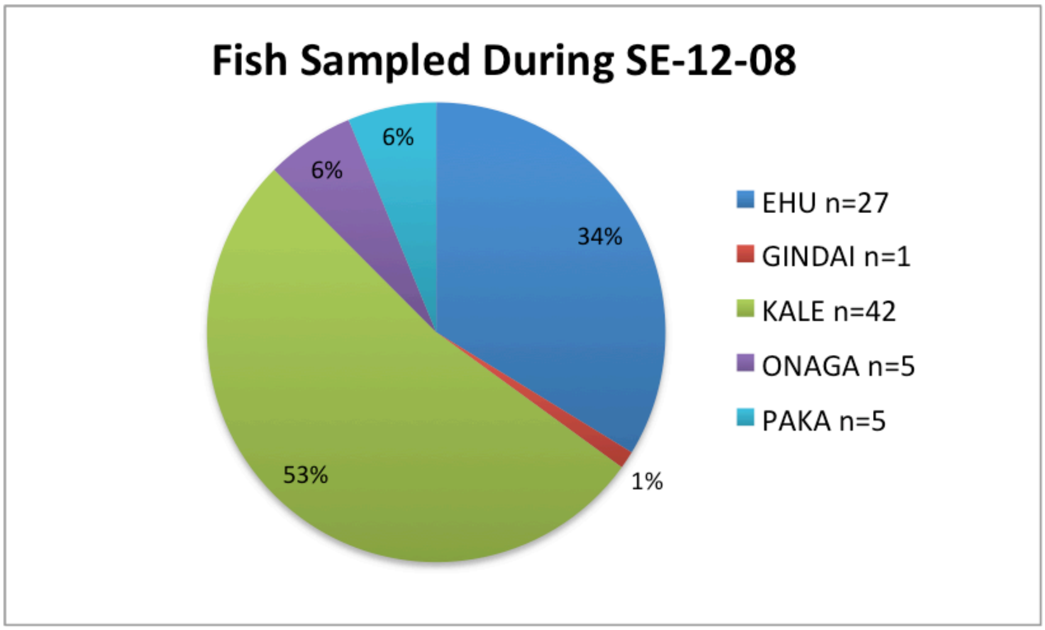

Figure 7.--A diagram showing the distribution of species provided for biosampling.

TOAD Camera Sled Operations (NOAA Ship *Oscar Elton Sette*)

EK60 surveys at PIFSC have had a long standing need to obtain verification of the species, size and abundance of fishes that have been acoustically detected and characterized. The TOAD camera sled (Fig. 8) was deployed on an experimental basis during SE-12-08 in an effort to collect optical imagery of targets detected during EK60 surveys. The TOAD had been used to support EK60 surveys on two occasions on past cruises, while the TOAD was deployed off the *Sette*'s starboard J-frame with the ship drifting. Results showed promise, but there have been concerns about the feasibility and safety of towing astern with the TOAD system. TOAD deployments on SE-12-08 were envisioned as a first step towards developing an optical characterization capability to support EK60 surveys, particularly of bottomfish communities.

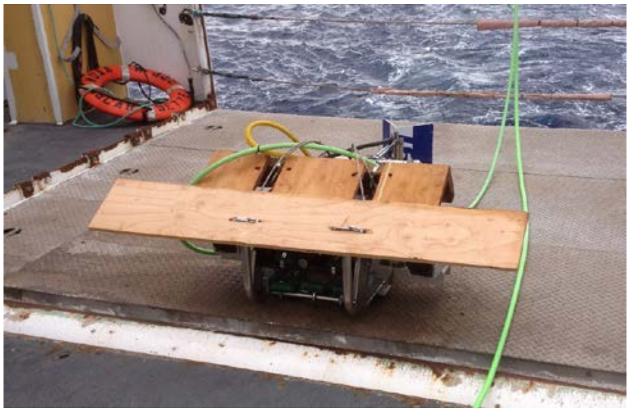

Figure 8 – The TOAD camera sled equipped with the maximum wing configuration tested during SE-12-08.

For SE-12-08, the TOAD was configured with a modular stereo camera system with two ROS Navigator low-light black and white video cameras and a digital video recorder in a dedicated pressure housing. Power was supplied by a feed from the TOAD's electronics bottle. Other instruments included a Deep Sea Power & Light Multiseacam 2060 color video camera, a pressure transducer, sonar altimeter, and fluxgate compass. All instruments besides the stereo cameras provided data in real time to a control console in the *Sette*'s E-lab. Extra lead was installed on the sled as well, providing a total in air weight estimated to be approximately 50 kg (110 lbs).

A test deployment and depth calibration were made after the *Sette* had anchored off Olowalu Maui with a two point moor and just prior to EK60 calibration at the beginning of the cruise. Following that, a total of 6 deployments were made in collaboration with EK60 transects covering 18.7 km. A number of other shorter deployments were made to check changes to the TOAD's configuration, to check the component pieces of equipment and for troubleshooting.

One of the original concerns about deploying the TOAD astern while underway was that it would be difficult to keep from losing equipment if the sled ever got hung up on the seafloor. However, during SE-12-08 the TOAD was never able to get anywhere close to the seafloor at bottomfish depths. From its initial in air weight of approximately 50 kg, another 18 kg of dive weights were gradually added. The TOAD's towing bridle configuration was changed a number of times and it was found that using only two points at the forward end of the sled for towing, with the other 2 bridle lines left slack but serving as backup attachment points, provided the most satisfactory towing configuration. PIFSC Ocean Engineer, Danny Merritt, devised two different wing configurations (both can be seen in the photo) to drive the sled closer to the seafloor. Each of these changes in configuration helped the TOAD get a bit closer to the seafloor. However, the deepest the TOAD was ever able to survey was 80-90 m, with the ship making way at 2.5 kts. The most significant problem appears to be drag from the umbilical cable. With a diameter of 2 cm, the cable was observed by the cameras to be near vertical near the sled during one deployment. Initial inquiries have been made about a possible replacement cable with fewer conductors, resulting in a smaller diameter and less drag. A new winch may be required as well, but efforts are planned to be compatible with and use the existing TOAD system components as much as possible. It is also anticipated that a sled with a different design will be required as well.

During TOAD deployments a number of problems developed with different pieces of equipment. Assistance by the ship's force with troubleshooting and resolving these problems is gratefully acknowledged. ET Joe Roessler assisted in identifying and resolving several issues. Of particular note was the expert assistance of First Engineer Michael Caserio. Mike spent considerable time, sometimes of his own volition and during off duty hours, testing and troubleshooting the 440V controller and motor on the TOAD winch. He provided invaluable assistance on several occasions, identified and corrected an incorrect electrical connection between the controller and motor, and gave very helpful advice about additional maintenance.

The existing TOAD system was found to be unsuitable in its present configuration for collecting optical imagery to validate EK60 acoustic characterizations at bottomfish depths. However, results of TOAD deployments during SE-12-08 demonstrated the feasibility of easily and safely deploying and recovering a vehicle astern with the A-frame while remaining clear of the ship's propellers and rudders, and of the vehicle's ability to remain stable while being towed. Results from SE-12-08 have also highlighted the next steps required to develop a capability to optically validate EK60 results.

Additional Projects

BRUVS (NOAA Ship *Oscar Elton Sette*)

Baited remote underwater video stations (BRUVS) were used during SE-12-08 to collect digital stereo-video data to estimate species-specific size-structured abundance (using the MaxN methodology) of targeted reef fishes both within and beyond those depths typically surveyed by SCUBA divers. This video data are also used to characterize the benthic habitat at the deployment site and to investigate species habitat relationships.

BRUVS are nondestructive baited stereo-video samplers which can provide scientifically rigorous estimates of fish abundance and size structure. BRUVS were originally developed by the lab of Dr. Euan Harvey at the University of Western Australia. The use of stereo-cameras enables accurate size (and hence length-frequency and biomass) estimates to be obtained. Each of a group of up to

8 units is deployed for approximately 15 minutes and is recovered and redeployed in a "leap frog" fashion throughout the day. This allows for considerable replication in space and time throughout the cruise.

BRUVS are termed 'remote' because the systems are deployed on the seafloor independent from an operator or observer. Each BRUVS system uses two off-the-shelf high definition (HD) video cameras mounted 0.7 m apart on a base bar that is inwardly converged at 8 degrees to gain an optimized field of view (with a forward-viewing range of ~ 10 m). These are placed within PVC pipe housings with acrylic front and rear ports, and mounted within a galvanized roll-bar frame. Stabilizing arms and bait arms (20 mm plastic conduit) are attached and detached during and after deployment.

Each BRUVS can be left unbaited or can accommodate up to 1 kg of bait, which is placed in a plastic-coated wire basket suspended on a bait arm 1.2 m in front of the unit. Alternative baits may be used, depending on supply/local availability. Each BRUVS is deployed by hand (each unit weighs ~ 50 kg) from the vessel at predefined GPS locations with a rope and floats attached. Established soak time is 15 to 60 minutes (depending on survey design), after which vessels can retrieve them by grappling surface floats and hauling lines with a hand-powered or electric winch or pot-hauler. Video footage can be reviewed as soon as the camera is retrieved to the vessel and can be archived for later analysis.

During SE-12-08, BRUVS were used to sample shallow and mesophotic reef fish assemblages at 50 sites across 6 depth categories. These surveys totaled 120 individual baited and unbaited deployments (Table 4).

CTD Drop Camera (NOAA Ship *Oscar Elton Sette*)

When it became clear that the TOAD camera system would not be able to reach bottomfish depths (> 100 m) with the current cable configuration, the ROS Navigator low light camera system was removed from the TOAD and was retrofitted to mount on the NOAA Ship *Oscar Elton Sette*'s CTD rosette. One camera was mounted in a downward-facing configuration while the other was mounted horizontally. If aggregations of significant interest were located during EK60 acoustic surveys, the location of the aggregation was marked. Following the survey, the ship returned to the marked location and attempted to relocate the aggregation. If the aggregation was relocated, the depth of the aggregation and water depth were noted and the CTD was lowered into the aggregation to optically verify the species composition. In the first attempt, the CTD drop camera system was lowered into an aggregation that has been persistent in grid 393 over multiple years. Footage from the CTD drop-camera suggests this school is primarily composed of *Naso hexacanthus* rather than bottomfish. This conclusion is supported by BotCam data.

In subsequent attempts, aggregations were noted and relocated using EK60 active acoustics and the CTD drop camera was lowered into the aggregation. Despite the fact that the trace of the CTD was visible in the EK60 returns and the CTD was seen to enter the aggregation, no fishes were observed. On one of these occasions this was likely due to the location of the aggregation at 285 m water depth, which is below the 250 m ambient-light recording depth limit for the cameras.

SCIENTIFIC PERSONNEL:

Benjamin Richards, Chief Scientist, Pacific Islands and Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS)
Gerard DiNardo, Stock Assessment Scientist, PIFSC, NMFS
Steven G. Smith, Stock Assessment Scientist, Rosenstiel School of Marine and Atmospheric Science (RSMS)
Jerald S. Ault, Stock Assessment Scientist, RSMS
John Rooney, TOAD Principal Investigator, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH)
Daniel Merritt, Marine Engineer, JIMAR, UH
Jacob Asher, BRUVS Lead, JIMAR, UH
James Barlow, Coxswain, PIFSC, NMFS
Megan Sundberg, Fisheries Technician, JIMAR, UH
Reka Domokos, EK60 Lead, PIFSC, NMFS
Abigail McCarthy, EK60 Acoustician, Northwest Fisheries Science Center, NMFS
Christopher Demarke,[1] BotCam Lead, Research Corporation of the University of Hawaii (RCUH)
Jason Friedman,[1] BotCam Technician, RCUH
Matthew Waterhouse,[1] RCUH
Jeffrey Drazen,[1] BotCam Principal Investigator, UH
Clay Tam,[2] PIFG Lead, Pacific Islands Fishery Group (PIFG)
Gary Dill,[3] PIFG Vessel Captain, PIFG
Robert Moffitt,[3] PIFG Observer, PIFG
Layne Nakagawa,[3]PIFG Vessel Captain, PIFG
Edward Ebisui,[3]PIFG Observer, PIFG
Kevin Awa,[3] PIFG Vessel Captain, PIFG
Brealand Tam,[3] PIFG Observer, PIFG

[1]Aboard the R/V *Huki Pono*
[2]Maui field support
[3]Aboard a PIFG cooperative fishing vessel

Submitted by: ______________________________

Benjamin L. Richards
Chief Scientist
Pacific Islands Fisheries Science Center

Approved by: ______________________________

Samuel G. Pooley
Science Director
Pacific Islands Fisheries Science Center

Attachments

Tables

Table 1.--EK60 Active Acoustics and BotCam Operations.

Survey Area	Depth Range	Number of Samples
B	80-120 m	19
B	121-200 m	5
B	201-300 m	5
D	80-120 m	1
D	121-200 m	23
D	201-300 m	36

Table 2.—Pacific Islands Fishery Group.

Survey Area	Depth Range	Number of Samples
B		
D		

Table 3.—Biosampling.

Species	Number
Ehu (*Etelis carbunculus*)	27
Gindai (*Pristipomoides zonatus*)	1
Kale kale (*Pristipomoides sieboldii*)	42
Onaga (*Etelis coruscans*)	5
Opakapaka (*Pristipomoides filamentosus*)	5

Table 4.—Baited Remote Underwater Videocamera Surveys.

Depth Range	# Sites Surveyed	Unbaited Deployments	Baited Deployments
0-6	13	18	8
6-18	16	22	15
18-30	4	6	3
30-53	11	22	9
53-76	5	10	4
76-100	1	2	1
Totals	50	80	40

Recommendations for Future Projects

- **EK60**
  - Written SOP for calibration & survey.
  - Move or shield EK60 transducer pod to reduce bubble sweep.
  - All of the ship's sounders (ADCP, 12kHz, 50kHz etc) should be secured to avoid interference with the scientific echosounders.
  - At least 1 CTD should be conducted for the calibration site and each survey area.
  - Redesign calibration downriggers based on NOAA Ship Oscar Dyson and MACE Alaska.
  - Construct a new bracket system for the downriggers to avoid the use of c-clamps–make the brackets either permanent on the ship or removable in one piece.
  - Permanently wire the cables for the downriggers for calibration.
  - Bring another echoview dongle on board so that we could run live-viewing in echoview and make annotations on the echogram while collecting data.
  - Conduct Methot or other mid-water trawl for sampling the top 20-30 m to ground truth "blue fuzz".
  - Use swivels/clips to join the three lines (port, starboard fwd, starboard aft) and attach the line with the sphere and weight on it, much less pain and angst with the tangled monofilament. Use braided line on the downriggers and monofilament for the line with the sphere and the weight.
  - Repair the 200 kHz transducer, de-foul other transducers. Make sure to follow the Simrad manual recommendations for proper de-fouling tools.
  - Investigate buggy connections between the GPTs and the ship's ER60 logger
  - Replace Stealth computer that is currently used to run EK60 system to prevent system crashes.

- **BotCam**
  - Use non-extractive methods before extractive methods for sampling each grid.
  - Consider shifting the boxes to encapsulate better bathymetry.
  - Some boxes may have to be eliminated due to accessibility and exposure to weather.
  - More reliable BotCam electronics with sufficient backups to maintain sampling continuity.

- **TOAD**
  - Obtain longer, non-buoyant cable to allow TOAD to reach greater depths appropriate for bottomfish.