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CRUISE REPORT[1]

VESSEL: *Oscar Elton Sette*, Cruise 05-05 (OES-27)

CRUISE PERIOD:
Leg I, 07-12 April, 2005
Leg II, 12-18 April, 2005
Leg III, 25 April–01 May, 2005

AREA OF OPERATION:
Leg I, Off Keahole Point, Island of Hawaii (Fig. 1)
Leg II, Kealakekua Bay, Island of Hawaii, and Finch Seamount (Fig. 1)
Leg III, Cross Seamount and control site (Fig. 1)

TYPE OF OPERATION: Oceanographic survey operations were conducted off Keahole Point during Leg I, at Finch Seamount during Leg II, and at Cross Seamount and at a control site for Cross Seamount during Leg III (Fig. 1). All survey operations consisted of 1000 m CTD casts as well as "deep" (~500 m) and "shallow" (~120 m) Cobb trawls along ADCP and EK60 transect lines. In addition, self noise testing of the EK60 echosounder's 38kHz and 120kHz transducers was conducted off the Kona Coast of the Island of Hawaii during Leg I (Fig. 1), and a passive acoustic instrument was deployed at Cross Seamount during Leg III. Further, the Simrad EK60 echosounder's transducers were calibrated in Kealakekua Bay during Leg II (Fig. 1).

[1] PIFSC Cruise Report CR-05-003
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ITINERARY:

07 April	Safety stand-down.
08 April	Start of cruise and Leg I. Embarked Réka Domokos, Elliott Lee Hazen, and Lucas Moxey. Departed Snug Harbor, Honolulu, at 1100 and proceeded to Kailua-Kona, Island of Hawaii. En route tested Cobb trawl gear and fixed malfunctioning net reel brake. Prior to reaching Kailua-Kona, noise measurements for the onboard Simrad EK60 bioacoustics instrument were conducted for the 38kHz and 120kHz frequencies.
09 April	Anchored off Kailua-Kona and embarked Jeffrey Polovina and Michael Seki. Proceeded to sampling site off Keahole Point and commenced survey operations.
10-12 April	Continued survey operations off Keahole Point.
12 April	Anchored off Kailua-Kona and disembarked Jeffrey Polovina and Michael Seki. End of Leg I. Begin Leg II. Embarked Marc Lammers and Donald Hawn and proceeded to Kealakekua Bay where the calibration of the Simrad EK60 echosounder was conducted.
13 April	Upon completion of the EK60 calibration, proceeded to Kailua-Kona and disembarked Marc Lammers. Departed Kailua-Kona and proceeded to Finch Seamount.
14-17 April	Conduced survey operations at Finch Seamount. Upon completion of survey operations (17 April, 1400), commenced transiting to Kailua-Kona, according to plan. However, an oil leak was discovered at the start of transit, resulting in an immediate halt of all scientific operations. The ship returned to Snug Harbor, Honolulu, to be repaired.
18 April	Arrived in Honolulu and disembarked Réka Domokos, Donald Hawn, Elliott Lee Hazen, and Lucas Moxey. End of Leg II.
18-25 April	Scientific operations were on hold while the sewage tank and one of the fuel tanks were emptied, cleaned, a quarter size hole between the two fixed, and the two tanks repainted.
25 April	Begin Leg III. Embarked Réka Domokos, Donald Hawn, Elliott Lee Hazen, Dave Johnston, Erwan Josse, Lucas Moxey, and Allan Sauter and departed for Cross Seamount.

26 April	Commenced survey operations at Cross Seamount in the early hours. Survey operations were temporarily ceased while a passive acoustic instrument was deployed at the summit of the seamount.
27-28 April	Continued with survey operations at Cross Seamount, then departed for Snug Harbor, Honolulu.
29 April	Anchored off Snug Harbor and departed Erwan Josse and two crew members. Departed for the Cross Seamount control site, approximately 100 nmi due south of Honolulu (~ 19° 38' N, 158° 08' W).
30 April	Conducted survey operations at control site.
01 May	Upon completing survey operations at the control site, commenced transit to Snug Harbor, Honolulu. Arrived Snug Harbor at 1030 and disembarked Réka Domokos, Donald Hawn, Elliott Lee Hazen, Dave Johnston, Lucas Moxey, and Allan Sauter. End of Leg III and cruise.

MISSIONS AND RESULTS:

A. Conduct noise measurements of the Simrad EK60 echosounder.

Background noise measurements of the 38kHz and 120kHz transducers were conducted off the Kona Coast of the Island of Hawaii, between latitude 19° 41.9' N, 156° 06.2' W and longitude 19° 35.3'N, 156° 02.4'W. These measurements are important as they determine the depth at which various back scatter values are reliable for the two frequencies at various vessel speeds and propeller revolutions. The test site was chosen to be at least 1 nmi offshore with calm seas and minimal currents, in at least 500 m depth water (the actual water depth was 1,300 m). The test consisted of taking background noise measurements for the two frequencies at vessel speeds of 0, 2, 4, 6, 8, and 10 knots and at 0, 50, 70, 95, 120, and 150 propeller/engine revolutions. The noise measurements were completed in about 2 hours with satisfactory results.

B. Calibration of the Simrad EK60 echosounder.

Kealakekua Bay was chosen as an ideal site for the calibration of the 38kHz and 120kHz EK60 transducers due to its shallow, protected waters with no waves and minimal currents. Calibration of the EK60's transducers has been successfully carried out previously on September 18, 2004, in the same location. After a brief survey of the bay, a site was chosen in ~50 m water with sandy bottom for the calibration. Prior to calibration, both the bow and stern anchors were deployed to maintain a stable position during the procedure.

The calibration involves the placement of a metal calibration sphere --- with known acoustic characteristics --- underneath the ship's hull-mounted transducers and recording the acoustic return from the sphere at positions that cover the entire circle of the transducers' beam. Since the 38kHz and 120kHz transducers are installed next to each other on a "pod" attached to the bottom of the ship's hull, the calibration recordings on the *Oscar Elton Sette* can be carried out once together for both frequencies. The position of the sphere is controlled by a three-reel electric system with monofilament lines leading from the reels to the sphere. The sphere can be centered below the transducers -- and below the ship – by placing two reels on the port side and one reel on the starboard side of the ship.

The positioning of the calibration sphere within the transducers' beam took minimal amount of time: once the sphere was attached to the three monofilament lines from the reels and lowered into the water to about 20 m depth, the sphere was within the transducers' beam. This was due to positioning the reels exactly as they were during the September 2004 calibration and also due to following the markings made at that previous time on the monofilament lines, indicating the length of line to let out from each reel. NOAA-certified divers, who pulled the starboard side monofilament line over to the port side underneath the ship – and who were waiting afterwards to help positioning the sphere within the transducers' beams – were relieved at the time the calibration sphere was in position. However, conditions in the bay were less then optimal at the time: the winds switched from trades to westerlies, resulting in small chops on the surface and low amplitude currents within the bay. The movement of the water made it difficult to position the calibration sphere at certain near-edge locations within the transducers' beams; further, it resulted in frequent slacks on the port side monofilament lines which doubled back on themselves on the reels and had to be manually uncoiled then recoiled. Due to these difficulties the calibration recordings could not be concluded before nightfall, forcing the ship to stay anchored until dawn the following day.

C. Conduct CTD casts to characterize three distinct physical environments: Near shore on the protected side of the Island of Hawaii (off Keahole Point), at a sea mount away from the wake of the Island of Hawaii (Finch Seamount), and at a sea mount in the wake of the Island of Hawaii (Cross Seamount).

A total of 31 CTD casts were conducted down to a nominal depth of 1000 m with 10 discrete water samples at depths 200 m, 150 m, 125 m, 100 m, 80 m, 65 m, 50 m, 35 m, 20 m, and surface for chloropigment determinations (Table 1).

At the Keahole Point survey site, four CTD casts were conducted at the corners of a 10-nmi by 10-nmi box. For these casts additional water samples were collected for nutrient measurements, with the deepest discrete sampling depths changed from 200 m to 300 m. Cast #3 had to be repeated (without water samples) due to the data file accidentally getting overwritten by the data file of the following cast.

At Finch and Cross Seamounts, 12 and 10 CTD casts were conducted over meridional and zonal transect lines, crossing over the summit. The length of transects and the number of casts were determined by the topography at the seamounts, taking into consideration the available time left for the surveys. At Finch Seamount, seven and five CTD casts were conducted over a 20-nmi meridional transect and a 15-nmi zonal transect, respectively. At Cross Seamount, five CTD casts were conducted along both a 16-nmi meridional transect and a 16-nmi zonal transect. Two of the 10 CTD casts at Cross Seamount were conducted over the summit in 333-335 m deep waters, where the maximum depths for the CTD's were approximately 310 m. With the exception of a single bottle not firing during two CTD casts at Finch and two CTD casts at Cross Seamounts, all CTD operations were completed successfully.

In addition to the CTD casts conducted at the three survey sites, four CTD casts were conducted at the control site for Cross Seamount along a transect line from latitude 19° 38.119' N, longitude 158° 09.011' W to latitude 19° 41.645' N, longitude 158° 00.766' W.

D. Conduct Cobb trawls targeting the deep and shallow high sonic scattering layers to better understand the acoustic signals collected by the EK60 echosounder.

A total of 34 Cobb trawls were conducted during the cruise (Table 1); 12 off Keahole Point, 9 at Finch Seamount, 9 at Cross Seamount, and 4 at the control site. During daytime, the high sonic scattering layer is typically between 500 and 800 meters deep, while during nighttime, there are two high scattering layers: one from about 20 to 150 m (the "shallow" layer, due to migratory organisms moving near the surface during the night), and one predominantly from 550 to 800 m (the "deep" layer). Daytime trawls targeted the deep scattering layer, while nighttime trawls targeted both the shallow and deep scattering layers. Net depths were monitored by the Northstar Netmind mensuration system, which failed to collect accurate depth data about 30-40% of the time, at which times net depths were estimated from Netmind temperature readings (if available) and/or the length of wire out.

As during previous cruises, the ship's hydraulic system would overheat during lowering the net to the deep scattering layer. To sidestep this problem, during deep trawls the hydraulics clutch was disengaged while lowering the net, so the net "dropped" to a depth by its own weight. During one deep trawl the clutch failed to disengage and it overheated. The trawl was aborted and pulled back up after letting the hydraulics cool for about an hour. Fortunately, during the next acoustic transect the clutch was fixed and the rest of the trawl operations were conducted without any further problems.

However, the length of the Cobb trawl cable is not sufficient for sampling the deep scattering layer. The most prominent (both widest and strongest) deep scattering layer is consistently between 600 m and 750 m -- sometimes even deeper than that -- while the net can be lowered to a maximum of 500 m. In addition to the most prominent deep layer, usually there are several scattering layers between 450-600 m, but those are typically too thin to target effectively. Further, these layers are much weaker than the deeper layer and most likely represent different kinds of organisms than the deeper one. Based on the 2.3 to 1 ratio of cable out to net depth, the 1200m long cables presently on the *Sette* should be replaced by 2000-m long ones to lower the net to 750 m and still have some cable left on the drums for security.

In addition, the Cobb trawl system needs some additional adjustments for it to work more smoothly -- and with less downtime due to tangled cables and nets. All existing hammerlocks should be replaced by heavy duty shackles, and a barrel swivel and hammer lock should be added to each line connecting to the triangles on each leg. Further, heavy duty swivels should be added to the top and bottom of each leg, and heavy duty swivels and shackles between the line and the doors. The added swivels would allow the free rotation of the doors and net relative to the cable, resulting in less tangled lines and a smoother operation of the entire Cobb trawl system.

E. Conduct EK60 and ADCP transects to monitor the bioacoustic scattering layer and currents.

A total of 125 acoustic transects were conducted during the cruise (Table 1): 28 EK60 and 7 ADCP transects off Keahole Point, 30 EK60 and 9 ADCP transects at Finch Seamount, 31 EK60 and 9 ADCP transects at Cross Seamount, and 8 EK60 and 3 ADCP transects at the control site (Table 1). Since the EK60's 38kHz and 120kHz transducers interfere with the ~70kHz ADCP transducer and vice versa, the Ek60 and ADCP systems were alternately turned on and off, collecting only half the amount of data that would be possible without this problem. Further, alternating EK60 and ADCP recordings preclude the direct comparison of bioacoustic and current data, limiting applicability of the results.

In addition to the interference between the EK60 and ADCP instruments, the bridge's 12kHz Simrad ES60 echosounder interferes with the EK60 transducers. The pings from the ES60 introduces considerable noise into the EK60 recordings which are not easy to take out in some circumstances and impossible in most. Since the ES60 serves as the bottom sensor for the *Sette*, it could only be turned off during certain times. Further, turning off the ES60 results in the unavailability of depth data during bioacoustics recordings, which would be an important component during data analysis, especially at seamounts or in nearshore environments.

One way to get around this interference problem and to be able to collect data from all three sounders simultaneously is to synchronize all acoustic instruments on the *Sette* by installing a specialized synchronizing software which would control the timing of the pings from all three instruments. To be able to resolve smaller targets, the EK60 should be set as "master" with the ADCP and ES60 as "slaves," since the bioacoustics data are expected to have spatial and temporal variability that is higher than that of the other two.

An even bigger problem with the EK60 data is noise due to bubbles and pressure waves that form below the transducers -- which can't easily escape due to the shape of both the ship and transducer pod. The resulting noise is so severe that it covers up all acoustic signals at most times in the open ocean. In open waters, even in the most favorable conditions (i.e., flat, glassy seas with no winds or waves), there is some water movement in the form of very small amplitude waves with relatively long wavelengths. Even these smallest of waves result in severe noise in the EK60 recordings during certain conditions. It seems that the direction of waves is more important than sea state for the EK60 data collection. If the waves are coming from aft – and the ES60 and ADCP are turned off - the EK60 bioacoustics data are noise-free. However, waves moving from the fore to aft result in noisy EK60 data even in the calmest and glassiest conditions. The noise is especially bad if the waves are approaching from the fore starboard side, where the transducer pod is located. On the other hand, even during rougher conditions, wave movements from aft to fore result in relatively noise-free bioacoustics data. All these observations correspond to the assessment that the location of the transducers on the *Sette* is the problem. The *Oscar Elton Sette* is a relatively flat bottomed wide vessel, with not much of a keel. On relatively wide, flat bottom vessels, the transducers should be positioned away and/or below the hull. The best way to achieve that would be mounting the transducers on a long pole attached to the side of the vessel, which can be swung down and anchored to the side of the ship when in use, and swung up, out of the water, when in transit. In this way the transducers would be away and below the hull of the vessel and, thus, away from the noisy "boundary layer." Further, the EK60 transducers would be away from the transducer pod with the ES60 and ADCP transducers, probably eliminating the interference between those and that of the EK60. Another advantage of a side-mounted system would be accessibility to the EK60 transducers without the need for a dry dock.

F. Deploy passive acoustic instrument (High frequency Acoustic Recording Package, or HARP) on Cross Seamount.

The passive acoustic instrument, or HARP, was deployed in the morning of April 26, 2005, about 1 km northeast from the summit of Cross Seamount, at ~ latitude 18° 43.3' N, longitude 158° 15.2' W. Taking the currents into consideration, a roughly 2 km by 2 km wide and 400-m deep plateau, with relatively smooth bathymetry, was chosen for the deployment, immediately E-NE from the summit. The HARP package was lifted over the side of the ship by a crane, lowered into the water, then let go to freely sink to the bottom; the entire procedure took less than an hour. Immediately after deployment, the package was successfully communicated with by a portable shipboard controller.

G. Miscellaneous.

1. Neither the positions nor the heights of Finch and Cross Seamounts are accurate on the navigational charts used by the *Oscar Elton Sette*. Finding the summit of Finch Seamount took approximately 2 to 3 hours after crossing over the location of the 1052-m deep summit -- as indicated on the charts -- with depth readings staying consistently below 5000 m. Upon completing 4-5 transects designed to determine the accurate position, the summit was located at latitude 17° 38.070'N, longitude 157° 41.723'W, 8.6 nmi off to the Northwest (due 237 degrees) from its position on the charts. Further, the minimum depth recorded by the ES60 was 995 m --- 57 meters shallower than expected. For locating the peak of Cross Seamount, a more recent map – obtained from a Seabeam survey conducted by the University of Hawaii with R/V K-o-K in 2001 – was utilized. The summit was located at latitude 18° 43.285' N, longitude 158° 15.710' W – in accordance with the Seabeam map – with 330m as the shallowest depth recorded.

2. Due to the time lost to ship repair, Leg III operations were seriously curtailed. The total scientific operational time accomplished for Leg III was 4 days, as opposed to the 10 days planned, significantly impacting some of the project's objectives. The original plan included – in addition to Cross Seamount and its single control site – survey operations at buoy NDCB 51002, at a control site for both buoy NDCB 51002 and Finch Seamount, and at an additional control site for Cross Seamount. Further, the number and length of original transect lines, as well as the number of CTD casts, over Cross Seamount had to be significantly reduced.

DATA COLLECTED:

The following forms, logs, charts, and data records were kept and given to the PIFSC upon termination of the cruise. These include all data captured onto computer storage media during the cruise. All the records are filed there unless indicated otherwise in parentheses.

CTD Station Log Sheet
Seabird CTD data files on DVD-R*
Marine Operations Log
Deck Log
Nobletech Navigational Map images on a CD-ROM
Cobb Trawl Log
Northstar Netmind data files on DVD-R*
ADCP Log
ADCP data files on DVD-R*
SCS data files (raw and compressed) on DVD-R*
XBT (SEAS) data files on DVD-R*

*All data files together on the same (1) DVD-R

SCIENTIFIC PERSONNEL:

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Attachments

Figure 1. OES 05-05 (OES-27) cruise track, April 08 – May 01, 2005.