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: *Oscar Elton Sette*, Cruise 05-07 (OES-29)

CRUISE PERIOD: 26 May-2 June 2005

AREA OF OPERATION: Kona coast off the Island of Hawaii (Fig. 1)

TYPE OF OPERATION: Operations conducted off the Kona coast included daytime surface net tows targeting billfish eggs and larvae 2-20 nmi off the Kona coast of the Island of Hawaii using a 1.8-m wide Isaacs-Kidd (IK) trawl. Night operations consisted of performing conductivity-temperature-depth (CTD) casts at predetermined transect positions and conducting acoustic Doppler current profiler (ADCP) transects along and off the Kona coast. A cooperative arrangement between Syd Kraul and Pacific Islands Fisheries Science Center (PIFSC) was undertaken in an attempt to raise IK collected billfish eggs to hatching and first feeding at Kraul's rearing facility on the Island of Hawaii. The *Sette's* safeboat was used to transfer viable eggs collected from net tows to Syd Kraul for pickup at Honokohau Harbor.

ITINERARY:

26 May — Embarked Robert Humphreys, Carly Allen, Michael Musyl, and Donna Vial. Departed Snug Harbor at 1330 and proceeded directly to Kailua-Kona, Island of Hawaii.

27 May — Arrived off the Kona coast at 0340 and conducted three CTD casts at predetermined sites along the northernmost CTD transect line. At around 0800 embarked John Hyde, Eric Lynn, and Russ Vetter from the Kailua-Kona pier. After embarkation, the ship transited to the south Kona coast and at 1042 began billfish egg and larvae collections with surface IK tows from the ship. At nightfall, commenced CTD casts to 150 meters depth at predetermined sampling sites.

[1]PIFSC Cruise Report CR-06-005
Issued 10 February 2006

28-31 May — Continued daily schedule of daylight surface IK tows from the ship. On May 28, billfish eggs were transferred to Syd Kraul at Honokohau Harbor. During nighttime, CTD casts at predetermined sampling sites and ADCP transects were conducted.

1 June — Conducted daylight surface IK tows from the ship. Transferred second and final batch of billfish eggs to Syd Kraul at Honokohau Harbor. At mid-afternoon discontinued net tow operations, disembarked John Hyde, Eric Lynn, and Russ Vetter at Kailua-Kona pier, and proceeded back to Snug Harbor, Honolulu.

2 June — Arrived Snug Harbor, Honolulu at 0700. Disembarked Humphreys, Allen, Musyl, and Vial; end of cruise.

MISSIONS AND RESULTS:

A. Collect egg and larval billfish specimens in surface waters along the Kona coast of Hawaii.

A total of fifty 1.8-meter wide Isaacs-Kidd (IK) tows were conducted; all tows were made with a 10-m length, 0.5-mm mesh nylon net. Tows were conducted at distances of 2-20 nmi offshore of the Kona coast between Keahole Point (19^0 42'N latitude) to the north and near Milolii (19^0 12'N latitude) to the south. Tows were conducted for 1 h alongside the ship off the port side J-frame. The IK net filtered the top 1-1.25 m of surface water including the neuston layer during all 50 surface tows.

The 1.8-meter IK net was specifically used to collect billfish eggs (finer 0.5-mm mesh and slower 2.75 to 3.0 knot towing speed). This contrasts with previous Kona cruises prior to 2003 where billfish larvae were targeted with 1.8-meter IK surface tows using nets with a substantially larger mesh size (front 4/5 of net 5-mm mesh, remainder 0.5-mm mesh, allowing a faster 4.0-knot towing speed). Use of the 1.8-meter wide IK with a 0.5-mm mesh net resulted in the occurrence of fish eggs varying in size from about 0.7 to 3.0 mm in diameter. For the majority of the tows, the entire sample was examined for billfish eggs and larvae. For those few tows with larger volumes, particularly larger amounts of flocculent material, the catch was first qualitatively sorted for egg size by pouring the entire tow contents through a column of graded sieves of 2.8-mm and 1.0-mm mesh. The contents that passed through the top 2.8-mm sieve and accumulated on the 1.0-mm sieve were immediately examined under magnification to remove any pigmented eggs suspected to be billfish. The remainder of each tow sample was then pooled and preserved in 95% ethanol for post-cruise examination.

Based on results of previous cruises, we felt capable of visually identifying swordfish and shortbill spearfish eggs based on their different sizes and distinct pigment patterns but were not confident in identifying blue marlin eggs without verification of species identification. To verify our confidence regarding the former two species, the first 12 swordfish and 10 shortbill spearfish eggs that were visually identified were also measured and photographed prior to subsequent destructive sampling via shipboard multiplex polymerase chain reaction (PCR) identification. All of these swordfish and shortbill

spearfish eggs were correctly identified and subsequently eggs of these two species were no longer identified using the PCR technique. A total of 43 other eggs suspected as blue marlin and/or wahoo eggs were PCR tested during the cruise and yielded 13 blue marlin and 7 wahoo eggs. Based on these PCR species identifications and the pigmentation differences between these two species and other identified billfish species, no further PCR testing was required to identify egg stages for these species collected thereafter. During this cruise, egg abundances were recorded for the following species; swordfish (n = 178 from 33 tows), blue marlin (n = 66 from 8 tows), shortbill spearfish (n = 42 from 18 tows), wahoo (n = 23 from 6 tows), and pompano dolphinfish (n = 1 from 1 tow). The highest catches of swordfish and shortbill spearfish eggs came from an area along the central to southern Kona coast while blue marlin and wahoo eggs were primarily captured along the central to northern Kona coast.

Net tows using the 1.8-meter IK also collected larval stages of billfish (n = 82) consisting of 29 swordfish, 29 shortbill spearfish, 16 blue marlin, 7 striped marlin, and 1 unidentified istiophorid larva. Shipboard multiplex PCR analysis was conducted to identify all (except one) istiophorid larvae collected. The verification of striped marlin larvae in the net tow catches provided the first recorded evidence of striped marlin spawning in the immediate vicinity of the main Hawaiian Islands.

For swordfish larvae, positive tows occurred in the central and southern portions along the Kona coast, but primarily along the southern Kona coast. Swordfish larvae were collected mostly during the mid-morning to mid-afternoon (0900 to 1500) period. Catches of shortbill spearfish larvae occurred along the central and southern portions of the Kona coast; most were collected in the late afternoon from 1600 to sunset. Larval blue marlin were primarily caught along the southern Kona coast from sunrise to 0900 and from 1500 to sunset. The striped marlin larvae were all collected off the southern Kona coast and taken throughout the day. Post-cruise processing of net tow samples will undoubtedly yield more billfish larvae (pre-flexion stage) that were overlooked during our initial at-sea processing.

B. Conduct DNA-based procedures for the identification of billfish eggs and larvae using a multiplex PCR (polymerase chain reaction) protocol.

Prior to initial DNA extraction, all eggs to be multiplex PCR tested were first digitally photographed under a dissecting microscope and then placed in individual microcentrifuge tubes of Chelex solution for DNA extraction. The entire egg was consumed during these procedures while for larvae, only one eyeball was extracted. Egg and tissue standards from known billfish species were periodically run with unknown egg and larvae samples to confirm results. The multiplex PCR technique provides rapid identifications (3 h processing time), ease of use, and shipboard adaptability which allows our billfish egg collection efforts to quickly adapt sampling schemes during the cruise.

With the net collection, digital imaging, and PCR identification of more blue marlin and wahoo eggs on this cruise than previously, the distinctive pigmentation patterns and size differences of swordfish, shortbill spearfish, blue marlin, and wahoo eggs should be able to be identified under a dissecting microscope. However, since the larval morphology of the

istiophorid species is rather similar, the identity of each larva should be verified using the multiplex PCR technique. Furthermore, since striped marlin larvae were found for the first time, there is the possibility that the larvae of the two other remaining billfish species (sailfish and black marlin) also could occur off the Kona coast. Since the egg stages of striped and black marlin and sailfish have yet to be described, it is unknown whether their size and pigmentation pattern are distinctively different from those known for the other billfish species. For these reasons, the multiplex PCR technique will still need to be used at sea to verify species identity in real-time, particularly if the ability to adaptively sample is desired.

C. Conduct nightly CTD casts at predetermined sites off the Kona coast.

A sampling grid of 15 Seabird CTD casts were conducted along four latitudinal transects off the Kona coast to acquire environmental data on the upper 150 m of the water column. Initial examination of the raw data indicated that sea surface temperature (SST) ranged from 25.9°C to 27.0°C (median SST was 26.4°C) along the Kona coast while sea surface salinity (SSS) varied from 34.37 to 34.55 psu (median SSS was 34.47). The mixed layer was between 90 and 120 meters deep as observed from the CTD stations.

Near surface current directionality, picked up by the shipboard ADCP, recorded a southerly current immediately adjacent to the Kona coastline that diverged offshore (to the west) in the southern portion of the Kona coast near Milolii. This current switched to a northerly direction some 15 to 20 nmi offshore and was redirected inshore (easterly direction) in the northern portion of the Kona coastline below Keahole Point. This clockwise rotational flow of near surface water was recorded throughout the duration of the cruise.

D. Cooperative arrangement between Syd Kraul and PIFSC to rear billfish eggs in captivity.

The examination of billfish eggs, removed from surface IK tow catches, indicated that many eggs were alive and apparently viable (based on observed heartbeats and tail twitching of embryos). After the collection and visual identification of species, these eggs were placed in a small plastic water bottle (by species) and held in a shipboard water bath at ambient SST. The first batch of eggs (84 swordfish and 6 shortbill spearfish) collected on May 28 were transferred by smallboat to Syd Kraul at Honokohau Harbor and then placed into a 780-liter outdoor rearing tank at Kraul's Keahole Point aquaculture facility. A second and final batch of 40 viable blue marlin and 6 swordfish eggs were transferred to Kraul on June 1. High egg mortalities were experienced by both batches. Of the first batch of billfish eggs, ~20 swordfish eggs hatched while only 1 swordfish and 1 blue marlin egg hatched from the second batch. Of the swordfish which hatched from the first batch, the larvae were apparently much less buoyant and were lying curled and inactive at the bottom of the tank; but not dead as heartbeats could be observed. From the second batch, one of the two larvae (swordfish) looked normal and was observed to be drifting in the tank occasionally swimming. This larva survived for 2 to 3 days post-hatch and had acquired pigments but eventually began to move about abnormally. The other larva (blue marlin) was curled up on the bottom occasionally attempting bursts of swimming. Afterwards this larva could not be resighted within the rearing tank. This first attempt is

somewhat encouraging although the trauma of net-capture and post-capture handling experienced by these eggs is probably a significant factor in their high pre-hatch mortality rate.

D. Miscellaneous observations.

Compared to the previous Kona egg and larval billfish cruise (OES 05-03) conducted only 2.5 months previously, the results from this cruise were completely different. Firstly, the persistent winds coming out of the north, west, and south during OES cruise 05-03 did not provide a lee effect off Kona. This was not the case during this cruise as the winds remained light and provided very flat sea surface conditions. Secondly, OES cruise 05-03 recorded no billfish eggs while the largest number of billfish eggs (for each species) were collected during this cruise, including the largest number of wahoo eggs thus far. Furthermore, this is the first cruise in which eggs and larvae of swordfish, shortbill spearfish, and blue marlin were found to co-occur off Kona. The first occurrence of striped marlin larvae during this cruise was initially thought to be a fluke event attributed to a single spawning event. However, the post-cruise mitochondrial DNA sequencing analysis of these larvae by John Hyde indicates that each of the seven striped marlin larvae originated from a different mother. It will be interesting to observe on future cruises whether a previously unrecorded pattern of limited seasonal striped marlin spawning has become established off Kona or whether these observations simply represent a rare event.

DATA COLLECTED:

The following forms, logs, charts, and data records were kept and given to the Pacific Islands Fisheries Science Center 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.

ADCP data files on DVD-R*
CTD Station Data Log Sheet
Seabird CTD data files on DVD-R*
Digital camera photos (JPG file format) on DVD-R*
Marine Operations Log
Deck Log
Plankton, Eggs and Larvae #1 (all net tows)
SCS data files (raw & compressed) on DVD-R*
Metadata files on DVD-R*

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

SCIENTIFIC PERSONNEL:

Robert L. Humphreys, Jr., Chief Scientist, National Marine Fisheries Service (NMFS), Pacific Islands Fisheries Science Center (PIFSC), WestLAB
Carly Allen, Cooperating Scientist, University of Hawaii (UH)
John Hyde, Cooperating Scientist, Scripps Institute of Oceanography
Eric Lynn, Fisheries Biologist, NMFS, Southwest Fisheries Science Center (SWFSC), La Jolla
Michael Musyl, Cooperating Scientist, Joint Institute for Marine and Atmospheric Research (JIMAR), UH
Russ Vetter, Fisheries Biologist, NMFS, SWFSC, La Jolla
Donna Vial, Teacher-at-sea, West Point Elementary

(/s/Robert L. Humphreys, Jr.)
Submitted by: _____
Robert L. Humphreys, Jr.
Chief Scientist

(/s/Samuel G. Pooley)
Approved by: _____
Samuel G. Pooley
Science Center Director
Pacific Islands Fisheries Science Center

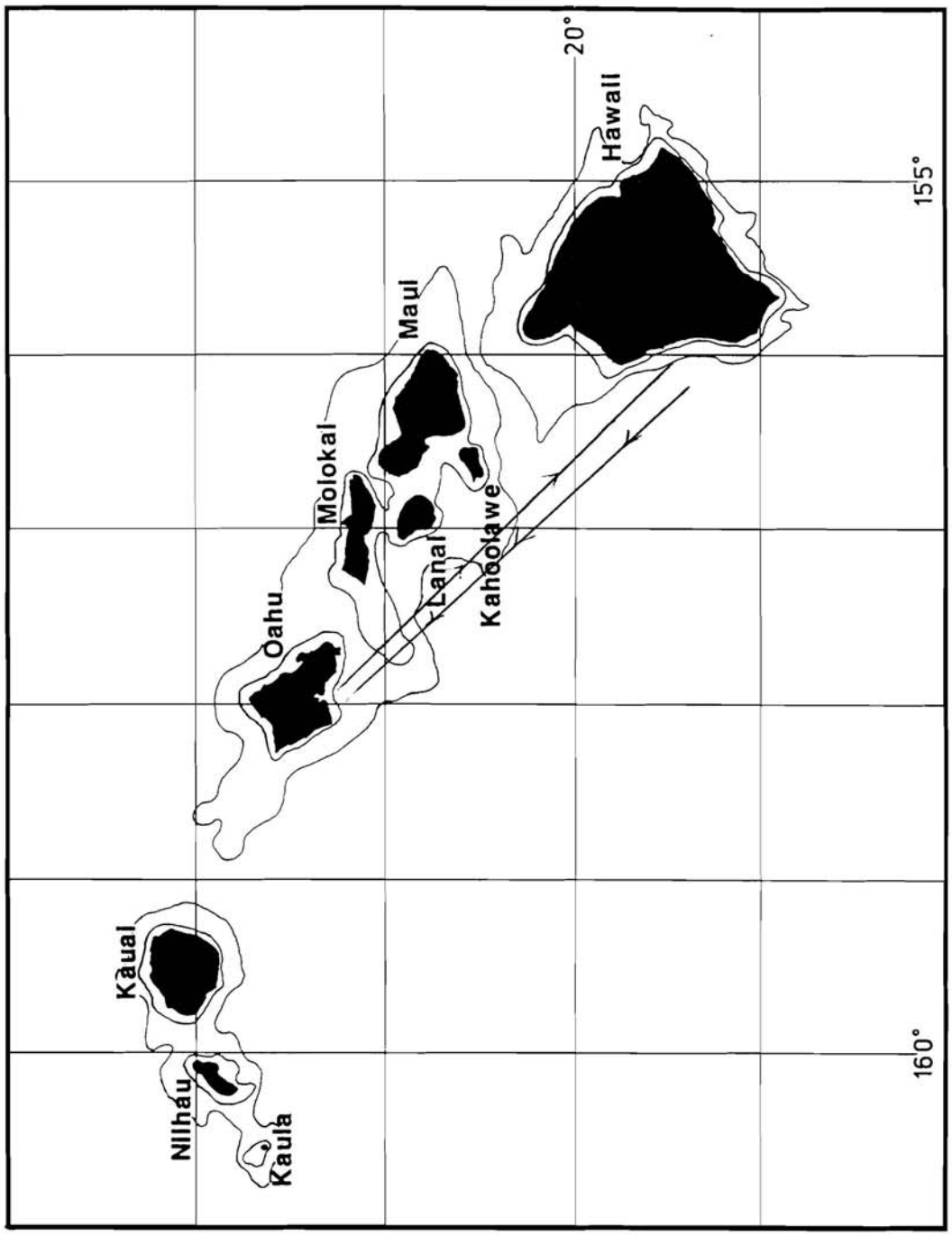

Figure 1.--Track of the NOAA ship Oscar Elton Sette cruise OES-05-07 (OES-29), May 26 to June 2, 2005.