



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES

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CRUISE REPORT¹

VESSEL: *Oscar Elton Sette*, Cruise SE-12-01

CRUISE PERIOD: 12 March 2012–26 March 2012

AREA OF OPERATION: Offshore fishing banks around American Samoa (Northeast Bank, Two Percent Bank, South Bank, see Fig. 1), and Tutuila.

TYPE OF OPERATION: The NOAA Ship *Oscar Elton Sette* was engaged in Fisheries Research as support for the Ecosystems and Oceanography Division (EOD) and Life History Program (LHP) of the Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS). The six primary missions involved A) oceanographic surveys of offshore fishing banks around American Samoa; B) the collection of adult eteline snappers and groupers for age, growth and maturity studies; C) midwater trawling surveys to characterize the distribution and abundance of early life history stages of insular species and pelagic forage assemblages; D) surface plankton/neuston tows and collection of fish stomach samples to survey microplastics distribution and abundance; E) oblique plankton tows to acquire copepod specimens for genetic studies; and F) utilization of BotCam to characterize behavior of deepwater bottomfishing gear. Daytime operations included conductivity-temperature-depth (CTD) deployments, surface net tows using a Mini-Manta neuston net, a 1.8-m Isaacs-Kidd Midwater Trawl (IKMT), 1-m obliquely towed ring net, small boat operations for deepwater bottomfishing, and BotCam. Nighttime

¹ PIFSC Cruise Report CR-12-002
Issued 21 May 2012



operations consisted of Cobb midwater trawl and 1-m obliquely towed ring net.

ITINERARY:

12 March	Start of cruise. Embarked Chief Scientist Donald Kobayashi, Evan Howell, Ryan Nichols, James Barlow, Meagan Sundberg, Louise Giuseffi, John Denton, Aimee Hoover, Megan Duncan, Jennifer Fry, Emily Norton, Tafito Aitaoto, Joshua Tuaumu, Faleselau Tuilagi, and Sione Lam Yuen. Departed Pago Pago Harbor and proceeded to Northeast Bank. Began survey operations with 2 CTD stations, neuston Mini-manta net station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
13 March	Conducted surveys around Northeast Bank. Launched SteelToe for small boat bottomfish sampling. Completed 3 CTD stations, neuston Mini-manta net station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
14 March	Conducted surveys around Northeast Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Completed 3 CTD stations, neuston Mini-manta net station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
15 March	Conducted surveys around Northeast Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Deployed BotCam from <i>Sette</i> and recovered from SteelToe. Completed 1 CTD station, neuston Mini-manta net station, oblique 1-meter net station, and 1 Cobb midwater trawl station to replace an earlier station which had a winch malfunction.
16 March	Conducted fueling at Pago Pago. Conducted surveys around Two Percent Bank. Completed 1 CTD station, neuston Mini-manta net station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
17 March	Conducted surveys around Two Percent Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Completed 3 CTD stations, neuston IKMT station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
18 March	Conducted surveys around Two Percent Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Completed 3 CTD stations, neuston IKMT station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.

19 March	Conducted surveys around Two Percent Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Deployed BotCam from <i>Sette</i> and recovered from SteelToe. Completed 3 CTD stations, neuston Mini-manta net station, oblique 1-meter net station, and 2 deep Cobb midwater trawl stations.
20 March	Conducted surveys around South Bank. Launched SteelToe for small boat bottomfish sampling. Completed 3 CTD stations, neuston IKMT station, oblique 1-meter net station, and 2 Cobb midwater trawl stations.
21 March	Conducted fueling at Pago Pago; disembarked Tuaumu, Tuilagi, and Yuen. Conducted surveys around South Bank. Completed 1 CTD station, neuston Mini-manta net station, oblique 1-meter net station, and 1 deep Cobb midwater trawl station.
22 March	Conducted surveys around South Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Completed 3 CTD stations and 2 Cobb midwater trawl stations.
23 March	Conducted surveys around South Bank. Launched SteelToe and NorthWind for small boat bottomfish sampling. Deployed BotCam from <i>Sette</i> and recovered from SteelToe. Completed 3 CTD stations, neuston Mini-manta net station, oblique 1-meter net station, and 2 deep Cobb midwater trawl stations.
24 March	Conducted surveys around western side of Tutuila. Launched SteelToe for small boat bottomfish sampling. Completed 8 CTD stations, and 1 deep Cobb midwater trawl station.
25 March	Demobilized all gear and scientific working areas. Processed samples and specimens.
26 March	Arrived Pago Pago Harbor. Disembarked Kobayashi, Howell, Nichols, Barlow, Sundberg, Giuseffi, Denton, Hoover, Duncan, Fry, Norton, and Aitaoto. End of cruise.

MISSIONS AND RESULTS:

- A. Conduct shipboard CTDs over and around fishing banks in American Samoa (Fig. 1) and around Tutuila using the SeaBird 9Plus, Seapoint fluorometer, SBE-32 carousel, and Turner 10-AU fluorometer in the hydro lab aboard the *Oscar Elton Sette*. Calibrate Seapoint fluorometer on the CTD with a correction curve using water samples from Niskin bottles. Construct vertical profiles and horizontal sections of salinity, temperature, dissolved oxygen, and chlorophyll-*a*.

1. The oceanography team completed 38 CTD casts on 3 established grids and 2 short transects west of Tutuila. Water samples were taken from 12 discrete depths on 7 stations. These samples were filtered and filters stored in acetone for 24 hours to extract chlorophyll. These samples were successfully processed on the Turner 10-AU in the hydro lab aboard the *Oscar Elton Sette*. Measured concentrations were plotted against concentrations measured by the Seapoint fluorometer on the CTD to create a correction curve. This curve showed that laboratory chlorophyll values were roughly half the value that the Seapoint fluorometer is reading (Fig. 2). This correction can be used for the rest of the 2012 *Sette* cruises if calibration parameters are unchanged within SeaSave. Water samples were not collected after station eight due to problems with the SBE-32 carousel. Bottle twelve on station eight would not fire, given an "unsupported modem message" within the SeaSave logs. Based on results from local troubleshooting and communication with Senior Survey Technician Phil White and representatives from SeaBird Electronics, we determined that the SBE-32 carousel was malfunctioning. During station 14 communication with the SeaBird 9Plus was lost at approximately 950 meters. Troubleshooting and deck tests revealed that the CTD system would not operate unless the SBE-32 unit was completely bypassed. The SBE-32 carousel was uncoupled from the system for the remainder of the cruise. The *Sette* immediately worked to secure a replacement SBE-32 unit for later cruises. The replacement arrived in Pago Pago and was successfully installed after arrival of the *Sette* in port on March 26, 2012. Deck testing to fire the pins on the SBE-32 was successful and water sampling should be able to resume on upcoming research cruises.
2. Physical oceanographic characteristics were fairly homogenous across the three banks with a slight shoaling in physical, chemical, and biological signals from north to south. Post-cruise processing of satellite altimetry data shows that a large cyclonic eddy was situated to the northwest of northeast and Two Percent Bank in the study area (Fig. 3). Acoustic Doppler current profiler (ADCP) data will confirm the current patterns yet the observed oceanography appears to be consistent with expected downwelling at the edge of a cyclonic eddy in the southern hemisphere. Pooled stations show a stratified upper layer, with mixed layer depths between roughly 40 and 50 meters from the surface. A subsurface salinity maximum was observed between 50 and 250 meters across all three banks. A thin subsurface oxygen maximum was also observed between 50 and 125 meters across all three banks, with this subsurface maximum vertically compressed at depth at south bank. The subsurface chlorophyll maximum was observed directly below the subsurface oxygen maximum across all three banks, with a shoaling of the subsurface chlorophyll maximum to the south. The lowest subsurface chlorophyll concentrations were observed at Two Percent Bank (Fig. 4).

3. One day of research effort was devoted to an attempt to observe reported upwelling off the western side of Tutuila. Eight CTD casts were done in an X-wing pattern over the reported area of historic upwelling. The stations to the southwest of Tutuila contained cooler surface temperatures, a shallower mixed layer, and enhanced chlorophyll concentrations through the water column, which may be indicative of upwelling of the southwest coast of the island (Fig. 5).
- B. Conduct bottom handline operations from small boats and the ship to obtain adult specimens of eteline snapper species for age/growth/maturity. For handline fishing from the small boats, four Henry Ching electric reels were spooled with 200-lb test Dacron backing and 180-lb test Power-pro® mainline. Terminal gear consisted of a 3-m long dropper with 6 branch lines of 50-lb monofilament test attached to 2-5 lb lead weight. Four to six circle hooks ranging in sizes from 14 to 22 were baited with strips of squid. Occasional fishing from the *Sette* was conducted in similar fashion but the three hydraulic fishing reels mounted to the ship's port side railing were used.
1. Bottomfish handline operations from small boats (SE-06 SteelToe and SE-04 NorthWind) took place during the 10 days of the research cruise. The two small boats conducted a total of 17 boat-fishing days with 277 drift fishing stations accomplished. Total time in the water for the SteelToe and Northwind combined was 53.3 hours over the duration of SE-12-01 research cruise. Fishing operations focused primarily along depth contours ranging from 50 to 150 fathoms directly over the offshore fishing banks (Fig. 1). *Sette*-based fishing was conducted on four days in the late afternoon and evening.
 2. Preliminary results reveal Two Percent Bank to be the most productive bank in terms of total fish landed. However, the number of each species obtained from each bank may have been influenced by the fishermen and may not be an actual representation of the species present. For example, we acquired a substantial number of *Aphareus*, *Pristipomoides* and *Paracaesio* species during previous fishing days but lacked *Etelis* species, particularly *E. carbunculus* specimens. While at South Bank, we attempted to avoid hook-ups of large-sized *Aphareus rutilans* by removing the top hook of our rigs connected to the palu bag and shifted to deeper water to avoid catching this species. Specific depths and contours were targeted in hopes of increasing catchability of *E. carbunculus* and *E. coruscans*. Our coxswains, Jamie Barlow and Mills Dunlap, became experts in "putting us on the spot" and were extremely successful in effectively reproducing drifts that produced sought-after species. We attempted to release fish species with a high catch rate, but most fishes suffered severe barotrauma, resulting in their retention.
 3. Operations were successful with regards to bottomfish sampling around the BotCam at South Bank, in which several *Aphareus*, *Etelis*, *Pristipomoides* and *Paracaesio* species were taken during the operation. The BotCam footage revealed large assemblages of various fish species congregating around the apparatus. It was suspected that we had several "hook-ups" with the unit itself

during our drifts over its location. We are optimistic that further examination of the footage will contain multiple views of fishing gear and hopefully show a fish being collected with the gear. Footage captured at Two Percent Bank showed several fishing rigs within the camera's field of vision.

4. In total, the small boat effort was very successful; we collected and retained 245 adult specimens for the South Pacific deepwater bottomfish life history study. All fork/total lengths and weights were taken and gonads removed and immediately stored in 10% histological grade formalin. Heads were also removed and frozen for later extraction of otoliths. We conducted three fishing operations in the vicinity of the BotCam and were able to complete operations early enough to add a bonus site of Western Tutuila around a coastal upwelling event. Five specimens were caught from *Sette*-based fishing operations.
5. The catch composition summaries by area and by sex are shown in Table 1A, 1B, as well as notes on specimens released alive after capture or kept as intact specimen for later processing (Table 1C).

C. Conduct midwater trawl survey around offshore fishing banks in American Samoa.

1. Midwater trawling (between 20 and 300 meters depth) was conducted at night to survey the diversity and biomass of organisms in the sound-scattering layers appearing at night before 9 PM and dispersing before dawn. Surveys sampled six biomass categories: myctophid fishes, non-myctophid fishes, cephalopods, crustaceans, gelatinous zooplankton, and miscellaneous zooplankton/smaller organisms. Surveys consisted of 12 trawling days and 23 total tows near the Northeast Bank (Muli Seamount), Two Percent Bank (near Tulaga Seamount), and South Bank (Papatua Guyot), with two of the trawls being midwater exploratory tows. After each tow, the entire catch was placed in a large metal bucket and sorted in the wetlab using plastic trays. All reef, bottomfish, and epipelagic fish larvae and juveniles were removed from each trawl haul and preserved in 95% ethanol. A subset of the catch (primarily gelatinous zooplankton, squid, and selected specimens such as cookie-cutter sharks) was frozen for later analysis. Patterns in volume proportions (see below) observed in the tows at these three locations reiterate some of the patterns observed in similar trawls off the Kona Coast during SE-11-04. For example, myctophid fishes remain abundant, comprising a quarter or more of the total volume for 10 tows. By contrast, few crustaceans were observed overall, although a 300 m-230 m stepped tow did produce many larger individual crustaceans (see below). The volume per site differed by slightly over 1 kilogram, with Two Percent Bank having the largest overall biomass volume, and Northeast Bank having the smallest overall biomass volume. Unlike SE-11-04, the total volume observed off Tutuila has been less than half that observed from the Kona Coast. The percentages of each of the six categories comprising the volume of each tow have been highly variable, with frequent outliers. A sharptail mola, the largest animal to ever appear in the *Sette* Cobb trawl, was caught and released, and did not

contribute to calculations. Additionally, several tows produced single, large cephalopods, and one tow was comprised predominantly of krill-like shrimp. The heterogeneity of trawl composition among sites reiterates the differences between the Kona Coast and American Samoa communities, and the processes generating the disjunct patterns observed off Tutuila demand further study.

2. Sampling of random individuals ($N = 25$) from each of four measureable categories (myctophid fishes, non-myctophid fishes, cephalopods, crustaceans) of the six total categories showed some qualitative distinctions among sites (below). Among non-myctophid fishes, median standard lengths (SL, mm) increased during the course of trawling activity from Northeast Bank to Two Percent Bank, with distinct intermediate median values at South Bank. By contrast, a different trend occurred in cephalopods, for which mantle length (ML, mm) decreased during trawling, from Northeast Bank to Two Percent Bank, and settled on the largest median values at South Bank. Additionally, all mesopelagic tows at 230 m-300 m produced large median lengths across the measureable groups, especially for crustacean total length (TL, mm), in which little pattern was otherwise discernable. No such pattern relating size and depth, size and duration of trawling activity, or size and location, is apparent in myctophid fish standard length. This result is potentially due to the complex size-stratification dynamics and diel migration cycles exhibited in these fishes. The size patterns observed from these random samples suggest the possibility that temporal factors (such as lunar cycle), in addition to spatial factors such as geographic location and depth, likely play a role in determining the distributions of different-sized organisms, and more work here is needed to identify candidate predictor variables.
3. The taxonomic diversity of myctophid and non-myctophid fishes appears to be quite different from that observed near the Kona Coast. Fewer typical mesopelagic non-myctophid fishes (e.g., dragonfishes, lightfishes, viperfishes, and swallows) have been observed at the depths sampled, and non-myctophid fishes have been comprised predominantly of juvenile shorefishes, with several billfish and boxfish larvae, pending identification; several cookie-cutter sharks; a live Sharptail Mola (*Masturus lanceolatus*); and an unusual horned juvenile butterfly fish (*Chaetodon ornatissimus*). Exploratory mesopelagic trawls to 300 m and 560 m were dominated by gonostomatids and chauliodontids, with a few astronothids. On the deepest trawls, several sternoptichids (hatchetfish), scorpaeniforms, and a possible alepocephaliform were obtained. Many of the non-myctophid fishes such as the acanthurid postlarvae (and other shorefishes) have been implicated as being important forage for tuna (David Itano, pers. commun.); hence, a better understanding of their distribution and abundance will be of critical importance in understanding the ecology of commercially important pelagic species of the region. Myctophid taxonomic diversity is markedly different from that near the Kona Coast, with far fewer *Lampanyctus* and *Ceratoscopelus* (except over South Bank), and greater numbers of *Bolinichthys*, *Benthosema*, and *Symbolophorus*. Specimens worthy of note include *Myctophum orientale*, normally found in the China Sea and the Sea of Japan; two beautifully preserved

Myctophum lychnobium/spinosum; *Hygophum hanseni*; *Lampadena cf. pontifex*; *Lampadena luminosa*; representatives of the slendertail myctophid genera *Gonichthys*, *Centrobranchus*, and possibly *Loweina*; and large numbers of an unusual *Benthosema* with highly ventrally displaced PVO1 photophores, apparently allied with *B. fibulatum*, that may constitute a new species. Exploratory mesopelagic trawls to 300 m and 560 m were dominated by nonmigratory, deep-bodied *Diaphus* species in the suborbital (So) photophore group.

- D. Conduct plankton/neuston survey and collect fish stomachs for characterizing microplastics distribution and abundance around American Samoa.
 1. Surface tows for microplastics were performed during the SE-12-01 cruise between March 12 and March 25. Twelve surface tows covered a total of 34 kilometers for a duration of 9.75 hours (Fig. 8). Nine of the tows were executed with the Mini-Manta trawl net (borrowed from The 5 Gyres Institute travel trawl program), which were 45 mins in length each off of the outrigger on the stern at 2 kts. The other three tows were performed using the IKMT for 60 minutes each from the port side J-frame at about 3.2 kts. From March 12 to March 16, five tows were performed on Northeast Bank, totaling 11.2 km. From March 17 to March 19, four tows were performed around Two Percent Bank totaling 14.6 km. From March 20 to March 25, three tows were performed on South Bank, totaling 8.3 km. From the tows examined, nearly every sample has contained synthetic debris, either visible to the naked eye or under the dissecting scope. The samples were stored in 95% ethanol for future quantitative processing. From the tows examined, nearly every sample has contained synthetic debris. Oblique tows for plankton to 200 m carried out by Emily Norton will also be examined for plastic debris present in the water column. During this study, persistent species were also found attached to drifting synthetic debris .
 2. Of the bottomfish retained by the Life History team for bio-sampling, stomachs were taken from 18 fish which did not experience severe barotrauma. These will be examined in the laboratory for the presence of synthetic material, plastics in particular. In addition, 945 deepwater specimens, primarily from the family Myctophidae, have been collected opportunistically from 11 of the nightly mesopelagic Cobb trawls during the cruise. They have been preserved in 95% ethanol for similar diet examination; a subset will undergo future analysis for ingestion of plastics.
- E. Conduct oblique plankton tows to collect copepod specimens for genetic analysis.
 1. Twelve oblique plankton tows were completed on SE-12-01 (Fig. 8). The total counts of target species individual specimens preserved in RNA later are 50 *Haloptilus longicornis*, 55 *Pleuromamma piseki*, 54 *P. xiphias*, and 10 pteropods (various species). The bulk samples for all 12 tows were preserved in 95%

ethanol and will be sorted in the Goetze laboratory at the University of Hawaii for other species of copepods and pteropods.

2. Over the course of this cruise, many plankton samples were obtained over a small geographic area near American Samoa. On the third of the American Samoa series of 2012 cruises (SE-12-03), Louise Giuseffi will conduct plankton tows during the *Sette*'s transit from American Samoa to Honolulu. These tows will greatly expand the spatial coverage of plankton samples collected for the Goetze lab. These valuable samples will be used to better understand connectivity and abundance patterns of the target species in the South Pacific Subtropical Gyre and the equatorial Pacific.
- F. Conduct BotCam operations in conjunction with small boat bottomfishing operations to observe fishing gear behavior and capture process.
1. Three BotCam operations were successfully undertaken on SE-12-01 using the *Sette* as the deployment platform and the SE-06 small boat as the recovery platform. On all three deployments the two small boats attempted to fish directly over the unit using GPS and the BotCam surface tether to guide their activities. No gear was damaged or lost except for the intentional losses of concrete blocks used as anchors for the BotCam unit. All three deployments yielded useable stereo video streams, which will be further processed by video technicians in the laboratory.
 2. Initial examination of Drop 2 footage indicated that fishing gear passed in front of or on top of the BotCam unit several times over the course of the day. In the frame seen in Figure 9, the squid-baited hook from a bottomfishing rig deployed from the surface, a small boat can be seen resting directly on the stereo camera synchronization device. In other sequences, palu bag chum dispersal was observed, as well as an actual hooking event of a *Pristipomoides*.

**SCIENTIFIC
PERSONNEL:**

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Submitted by:



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Approved by:



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Attachments

Tables

Table 1A.--List of fish specimens processed for life history studies summarized by location.

Species	Total	Northeast Bank	Two Percent Bank	South Bank	West Tutuila
<i>Aphareus furca</i>	4	0	4	0	0
<i>Aphareus rutilans</i>	38	9	21	8	0
<i>Caranx lugubris</i>	1	1	0	0	0
<i>Cephalopholis igarashiensis</i>	3	1	1	1	0
<i>Epinephalus longispinus</i>	1	1	0	0	0
<i>Etelis carbunculus</i>	20	1	4	14	1
<i>Etelis coruscans</i>	25	0	17	7	1
<i>Etelis radiosus</i>	1	0	1	0	0
<i>Gymnosarda unicolor</i>	1	0	1	0	0
<i>Lethrinus olivaceus</i>	1	0	0	0	1
<i>Lutjanus bohar</i>	4	4	0	0	0
<i>Paracaesio kusakarii</i>	18	12	3	3	0
<i>Paracaesio stonei</i>	4	1	3	0	0
<i>Paracaesio xanthura</i>	2	0	2	0	0
<i>Pontinus macrocephalus</i>	1	0	0	1	0
<i>Pristipomoides auricilla</i>	41	21	16	4	0
<i>Pristipomoides filamentosus</i>	13	0	7	6	0
<i>Pristipomoides flavipinnis</i>	60	7	35	18	0
<i>Pristipomoides zonatus</i>	10	2	6	1	1
<i>Unidentified Grouper</i>	2	0	2	0	0

Table 1B.--List of fish specimens processed for life history studies summarized by gender.

Species	Total	Male	Female	Unknown
<i>Aphareus furca</i>	4	3	1	0
<i>Aphareus rutilans</i>	38	9	29	0
<i>Caranx lugubris</i>	1	0	0	1
<i>Cephalopholis igarashiensis</i>	3	0	0	3
<i>Epinephalus longispinus</i>	1	0	1	0
<i>Etelis carbunculus</i>	20	6	14	0
<i>Etelis coruscans</i>	25	11	14	0
<i>Etelis radius</i>	1	0	1	0
<i>Gymnosarda unicolor</i>	1	0	1	0
<i>Lethrinus olivaceus</i>	1	0	1	0
<i>Lutjanus bohar</i>	4	0	0	4
<i>Paracaesio kusakarii</i>	18	6	12	0
<i>Paracaesio stonei</i>	4	1	2	1
<i>Paracaesio xanthura</i>	2	1	1	0
<i>Pontinus macrocephalus</i>	1	1	0	0
<i>Pristipomoides auricilla</i>	41	9	31	1
<i>Pristipomoides filamentosus</i>	13	7	5	1
<i>Pristipomoides flavipinnis</i>	60	37	23	0
<i>Pristipomoides zonatus</i>	10	0	10	0
<i>Unidentified Grouper</i>	2	0	0	2

Table 1C.--List of fish specimens released or kept intact for later processing.

Fish Released	Total
<i>Caranx lugubris</i>	10
<i>Carcharhinus</i> <i>longimanus</i>	1
<i>Lutjanis bohar</i>	1
<i>Paracaesio kusakarri</i>	7
<i>Paracaesio stoneii</i>	2
<i>Pristipomoides</i> <i>flavipinnis</i>	2

Kept But not Processed	Total
<i>Gymnosarda unicolor</i>	1
Unidentified Grouper	2
<i>Thyrsitoides marleyi?</i>	1
<i>Thunnus albacares</i>	1

Figures

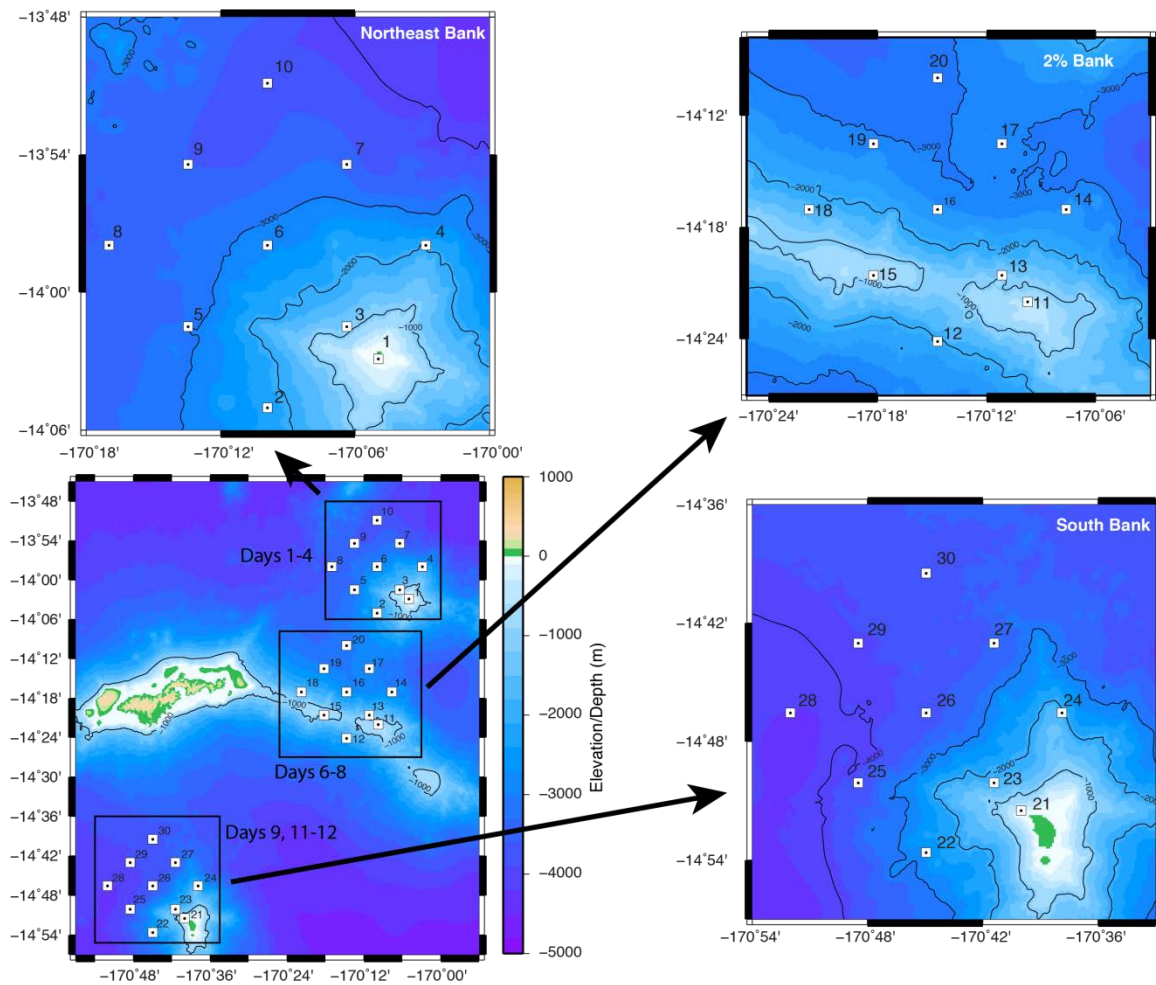


Figure 1.--Location of primary survey sites for SE-12-01 research cruise.

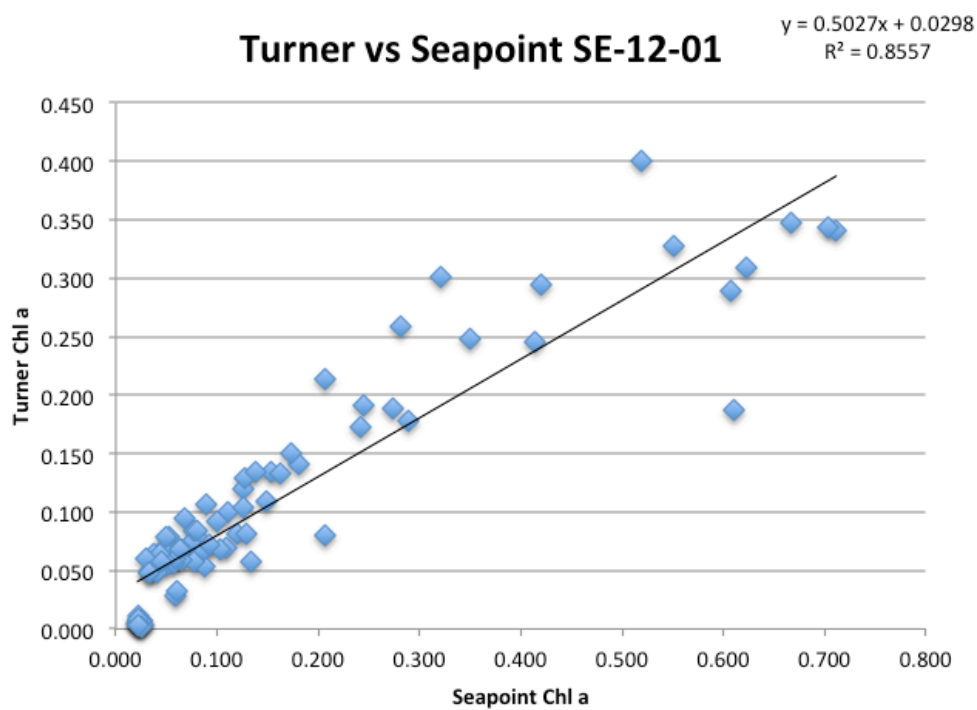


Figure 2.--Calibration curve for CTD flurometer based on water samples.

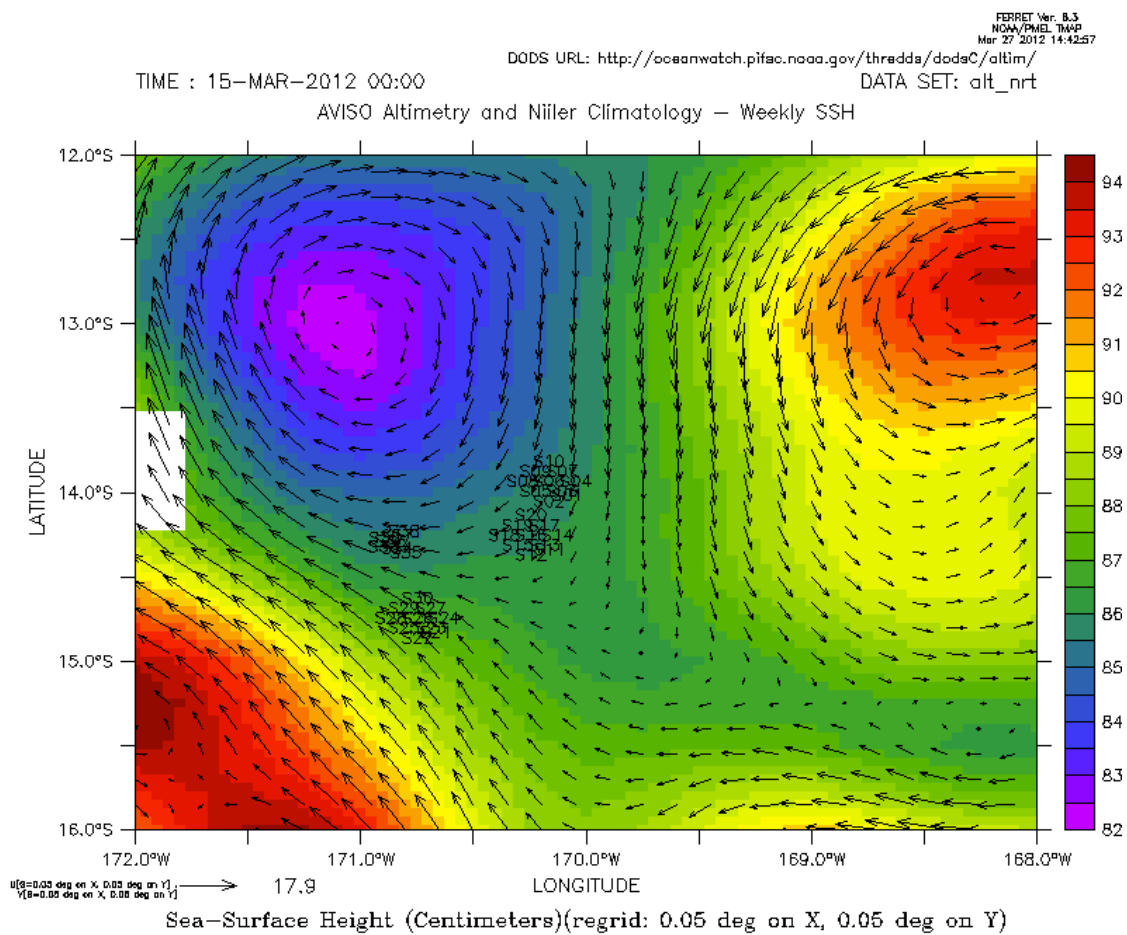


Figure 3.--Eddy northwest of study area during research cruise as shown by satellite imagery of sea surface height.

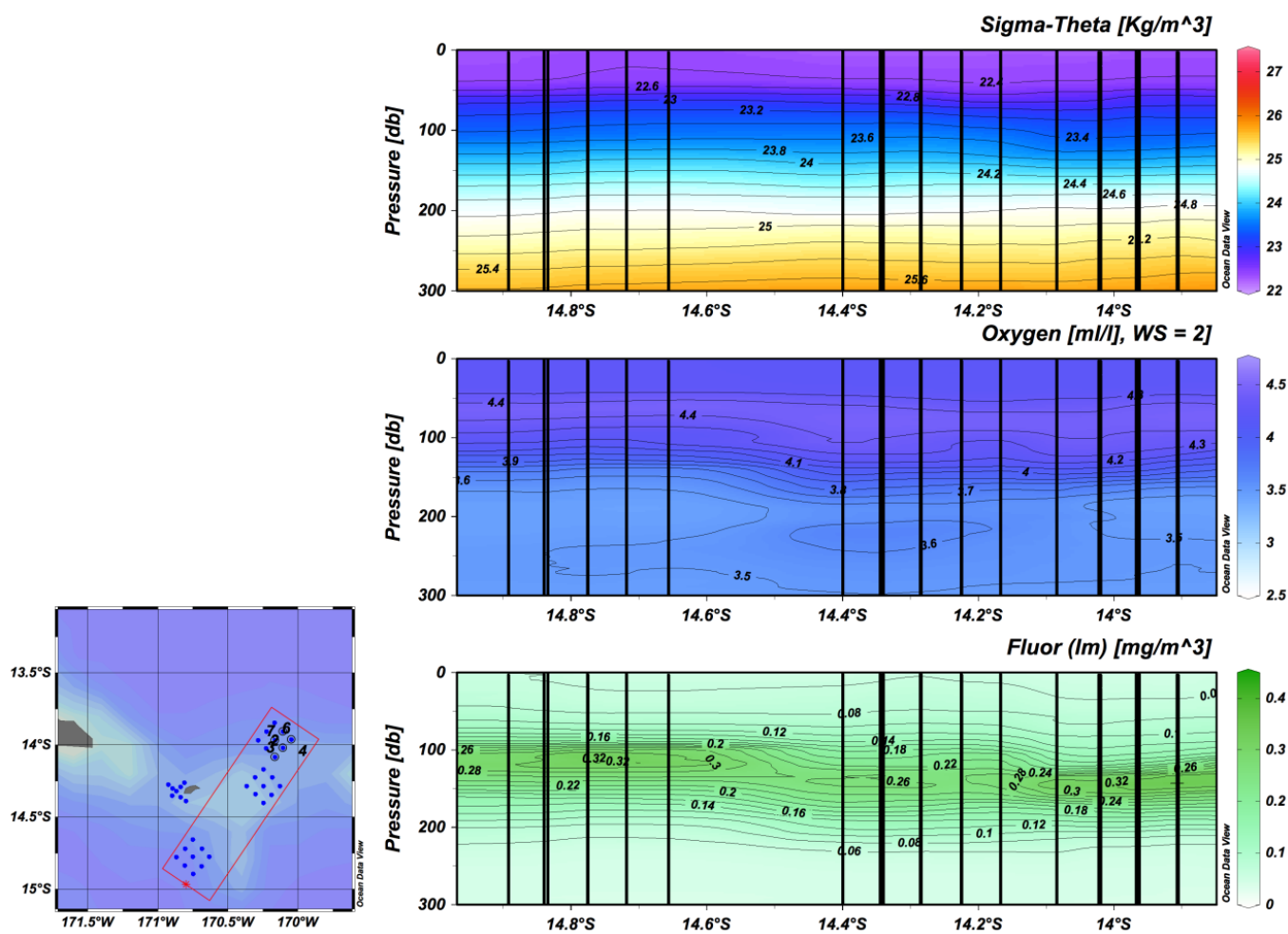


Figure 4.--Vertical and horizontal patterns in oceanographic parameters derived from CTD surveys around offshore fishing banks.

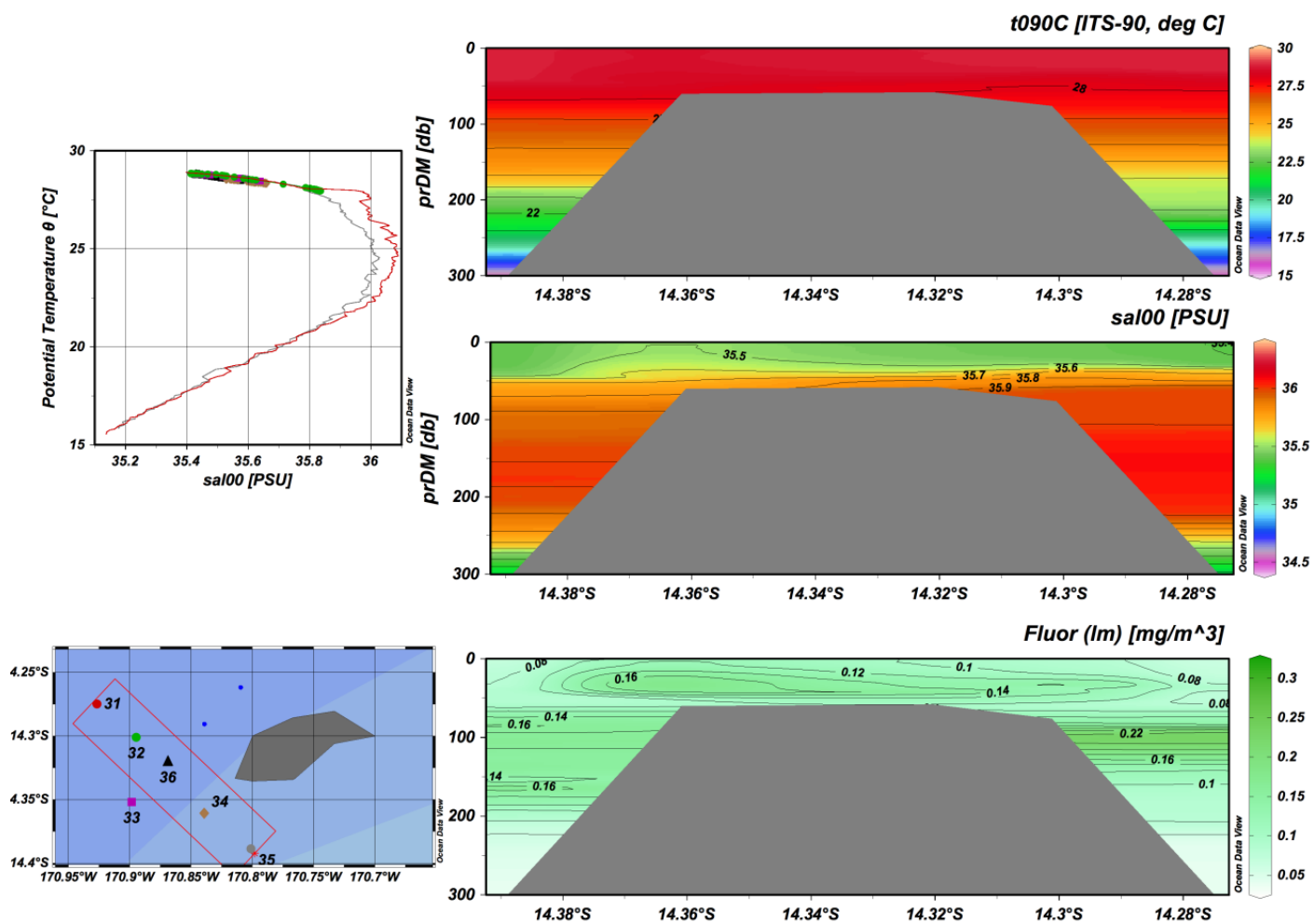


Figure 5.--Vertical and horizontal patterns of oceanographic parameters derived from CTD survey around western Tutuila upwelling area.

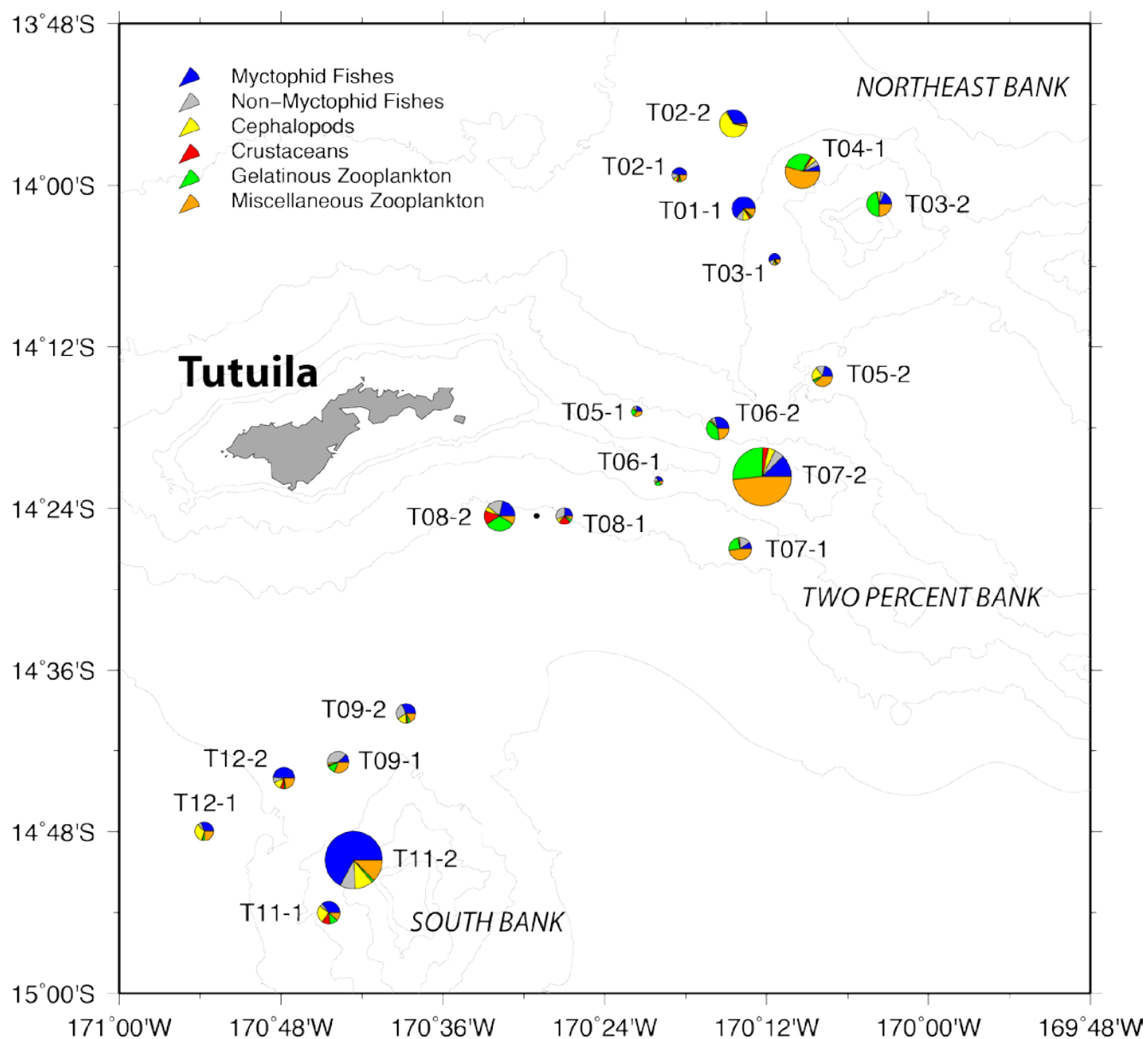


Figure 6.--Summary of Cobb trawl surveys around offshore fishing banks. Pie charts represent breakdown of trawl contents into 6 components of biomass.

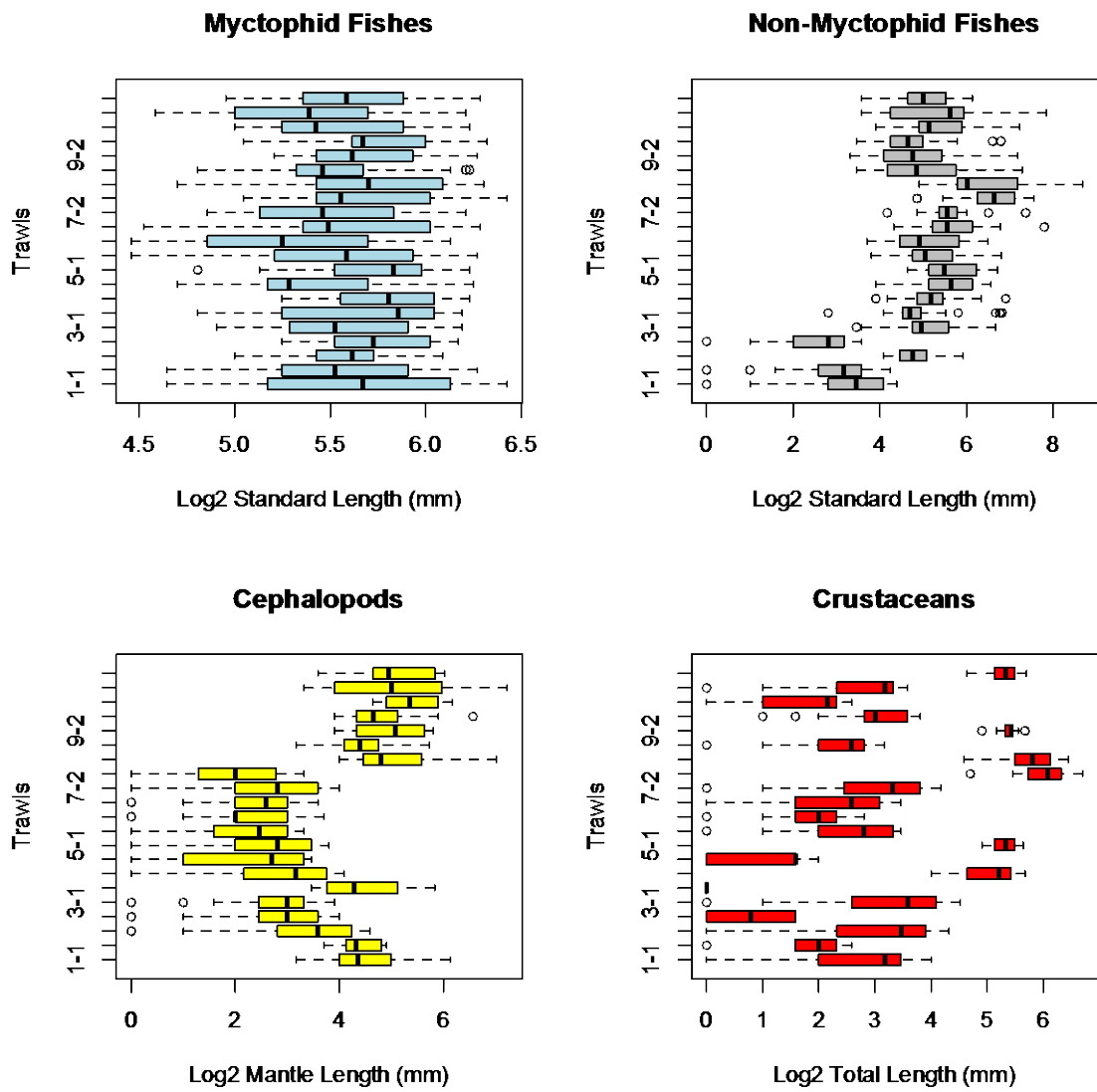


Figure 7.--Mean length of random individuals from 4 categories of Cobb trawl catch.

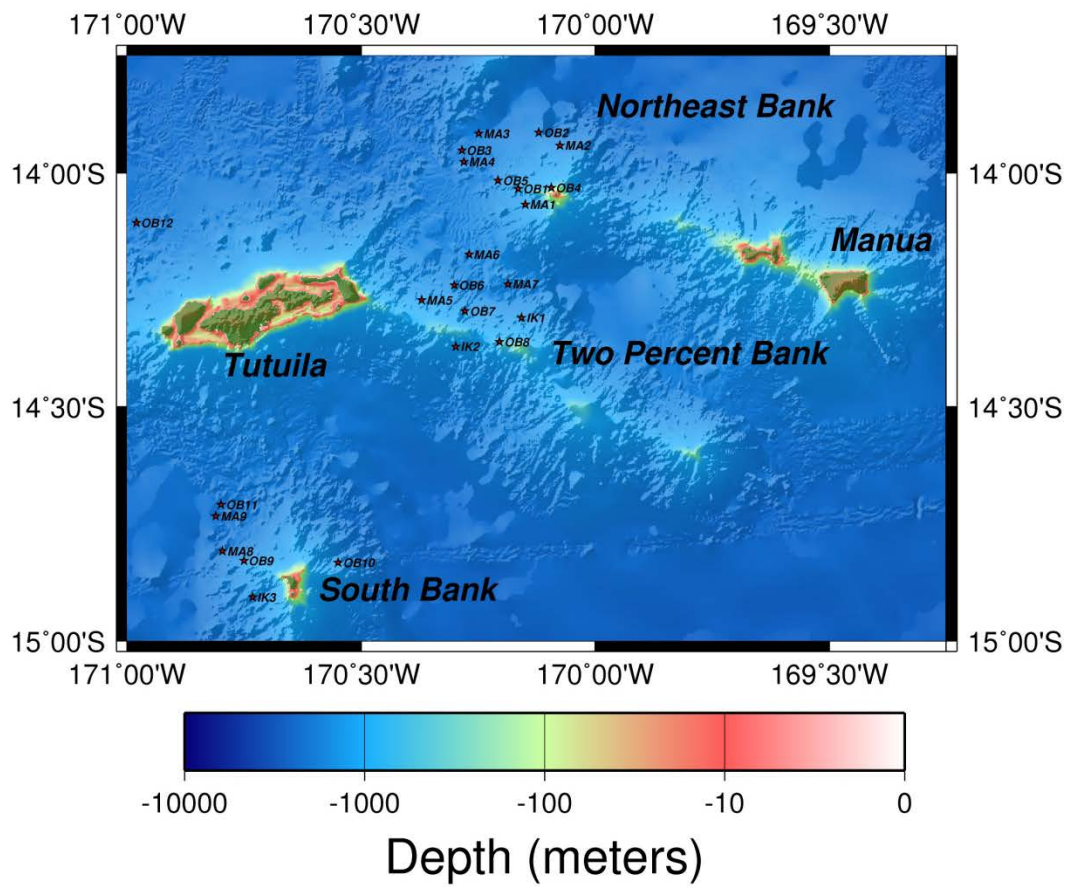


Figure 8.--Location of towed gear surveys using Mini-manta net (MA), Isaacs-Kidd Midwater Trawl (IK), and 1-m oblique net (OB) on research cruise SE-12-01 around American Samoa.

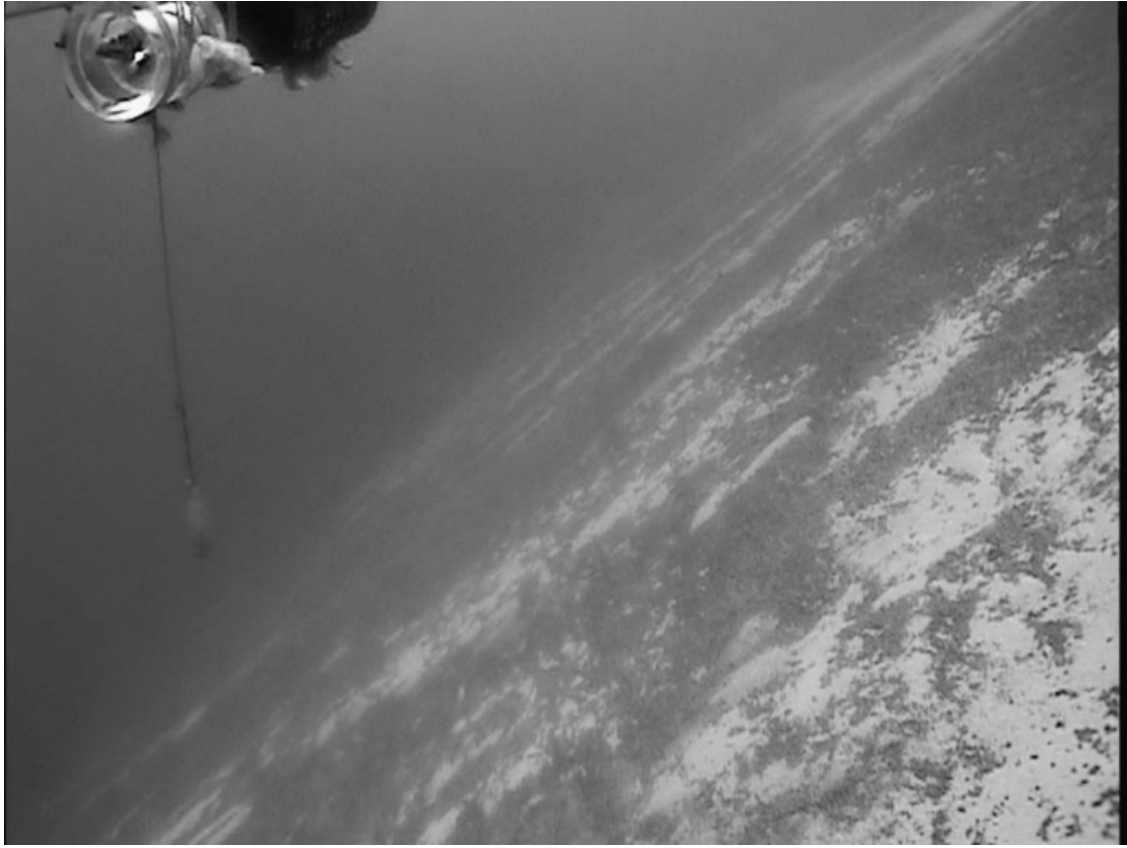


Figure 9.--BotCam frame from Two Percent bank showing baited hook from small boat draped over camera synchronization device. Note the extremely steep relief at this site, based on the plumb-line dangling from the camera synchronization device.