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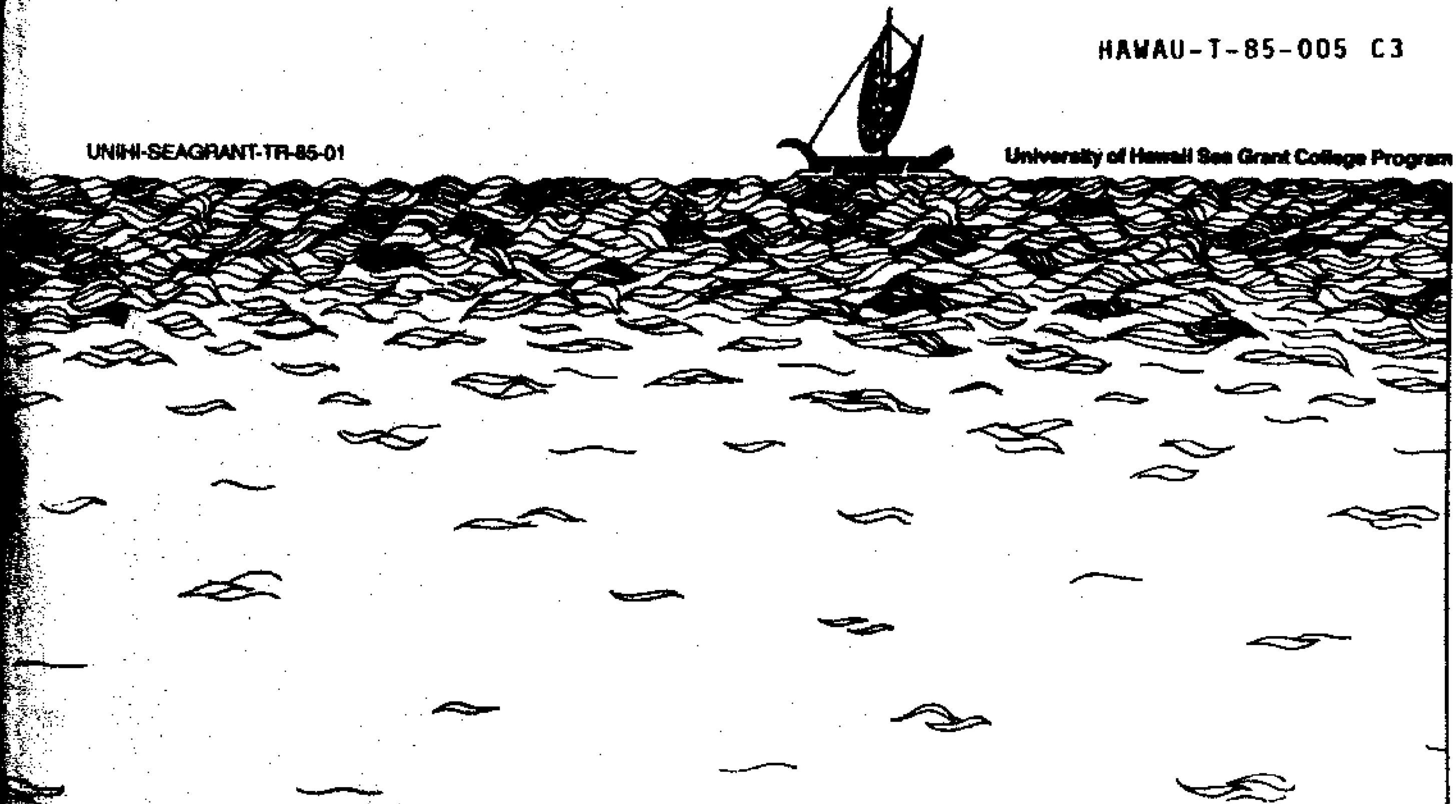

Oceanographic Observations of the Fishing Area Off Hilo, Hawaii

Satoru Taguchi, Jed Hirota, Edward D. Stroup,
Tsuneyoshi Suzuki, Richard Young, and Robert Harman

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ABSTRACT

During a U.S.-Japan cooperative research cruise aboard the *Hokusei Maru*, the waters off Hilo, Hawaii were surveyed to determine possible reasons for the high abundance of squids in this area. No evidence of strong currents or of upwelling was detected. Nutrient and chlorophyll *a* concentrations and micro- and macrozooplankton standing stock exhibited spatial variation over the region, but most values were typical of those found in Hawaiian waters. Unusually high values of nutrients, however, were observed near the head of the Puna Canyon where considerable shoreline freshwater discharge was detected in the salinity data. In the northern stations, unusually high catch rates of the squid, *Sthenoteuthis oualaniensis*, were observed. These squid were mostly larger than those taken at the southern stations and, in contrast to the latter, they had fed heavily on the midwater shrimp, *Oplophorus* sp.

ACKNOWLEDGMENTS

This study is the result of research sponsored in part by the Faculty of Fisheries, Hokkaido University, Japan. We wish to thank Captain Shoichi Yamamoto of the fishery training ship *Hokusei Maru* and his officers, crew, and cadets for their skill and assistance during the cruise. We also thank the National Marine Fisheries Service personnel for their assistance in gathering data. We are indebted to the University of Hawaii Sea Grant College Program for their financial support.

TABLE OF CONTENTS

LIST OF FIGURES

Figure

INTRODUCTION

In February 1983 the Hokkaido University fishery training vessel, *Hokusei Maru,* made the third in a series of U.S.-Japan cooperative research cruises in Hawaiian waters. The cruises, initiated by the Honolulu Laboratory of the National Marine Fisheries Service (NMFS), were originally intended to assess squid resources around the Hawaiian islands; however, poor catches and changing interests of the participants resulted in the formation of new objectives directed toward a better understanding of the ecology of the dominant ommastrephid squids. The 1983 cruise was divided into several legs, the second of which is the subject of this data report. The objectives of leg II were to examine oceanographic and biological factors that could be responsible for the apparent high accumulation of squids as well as tunas in the waters off Hilo, Hawaii.

Leg II was undertaken in cooperation with scientists from the Department of Oceanography, University of Hawaii (UH) at Manoa; the Department of Biology, UH at Hilo; and the Department of Oceanography, Texas A&M University. The U.S. scientists were sponsored by the UH Sea Grant College Program. The cruise plan was designed by UH scientists in cooperation with NMFS biologists.

The waters off Hilo are considered by many fishermen to be the best fishing grounds for tunas around the main Hawaiian islands. Catch data supplied by NMFS in part support this contention. For waters within approximately 60 miles of the Hawaiian islands, 37 percent of the 1970-79 handline catch of bigeye, yellowfin, and albacore tunas came from the areas off Hilo and nearby Point Kumukahi. On the other hand, only 9 percent of the total longline catches for these species came from these areas. The total state handline catch for these species is about 80 percent of the total state longline catch.

The Hilo waters are also distinctive in being the only region in the Hawaiian Archipelago that has supported a squid fishery. According to Yuen (1979), the squid fishery probably began in the early part of this century. Following World War II, fishermen began catching tunas, which gradually became the primary target of the fishery, and captured squid became the principal bait. Both tunas and squid are caught primarily by handline at night (ika-shibi fishery). The 1975 handline catch of tunas was 154.6 tons and the catch of squid not used for bait was 1.3 tons. The season for the ika-shibi fishery is from July through December.

Since leg II took place in the off-season for the fishery (the cruise dates were determined by the availability of the *Hokusei Maru*), only baseline data could be established for comparison with data to be taken during future cruises. In planning the sampling regime two hypotheses which could explain the apparent high concentration of fish and squid in these waters were considered:

Hypothesis 1. Nutrient input into the surface waters off Hilo is greater than is typical for Hawaiian waters. Two possible ways that seem most likely for surface nutrient content in the area to be substantially increased are (a) by the local upwelling of deep, nutrient-rich water or (b) by the discharge of nutrient-rich fresh water from the adjacent island. For nutrient input to have an effect on a local fishery, the general circulation in the area must be contained or else production resulting from the nutrient input would reach the higher trophic levels downstream.

Hypothesis 2. A higher number of forage animals exist in these waters due to some type of concentrating effect as the animals are carried by currents toward the island. Some fishermen believe that the tuna feed on the squid; this fact has yet to be established, however. Both tunas and squids could be foraging on the same prey.

Other hypotheses could be generated. Our initial efforts, however, were directed at the above two hypotheses, which we considered to be the most probable.

On leg II we examined features that would allow us to detect local input of nutrients, to identify the dominant species of squids, to determine the relative and areal abundance of these squids, and to determine the principal prey of the squids. Temperature and salinity data were analyzed by officers of the *Hokusei Maru*

In the "Results and Discussion" section below, the part on temperature, salinity, and currents was written by Edward D. Stroup; the part on nutrients by Satoru Taguchi and Edward D. Stroup; the part on chlorophyll by Satoru Taguchi; the part on zooplankton by Jed Hirota; and the part on squid by Tsuneyoshi Suzuki, Richard Young, and Robert Harman.

MATERIALS AND METHODS

Physical Measurements

A survey of surface waters over the entire area of study was conducted at maximum ship's speed (approximately 10 kt) for 20 hours on February 5-6, 1983 (Figure 1). Surface water was collected by bucket every 15 minutes for nutrient (Appendix A) and chlorophyll analyses, and an XBT (expendable bathythermograph) was dropped every hour (Appendix B). A ship-mounted thermograph was used to monitor the surface temperature continuously. Salinity was also measured.

Twenty oceanographic squid jigging stations were surveyed between February 7 and 10, 1983 (Figure 2). At each station a stratified series of 11 Nansen bottles were lowered to a depth of 400 m (see Appendix C for depth spacing). Temperature was measured with a reversing thermometer and salinity was determined on board with a salinometer. Light penetration was measured with a Secchi disc at day stations (24, 33, 34, 35, 39, 40, 41, 42, and 43).

Nutrient Analysis

Water samples were collected with 12-liter PVC Niskin samplers at depths of 10, 25, 50, 75, 100, 125, 150, 175, 200, and 250 m, as well as with a bucket at the surface. Subsamples were drawn for nutrient analysis. A 1-liter sample was filtered through a Whatman 47-mm GF/C glass fiber filter to collect a filtrate. A 300-ml filtrate was stored in a whirl-bag for each species of nutrients and kept at -20°C in darkness. Concentrations of nitrate plus nitrite and silicate were determined with a Beckman model DU 8 spectrometer using the method described by Strickland and Parsons (1972).

Chlorophyll Analysis

The same filter used for collecting the nutrient sample was stored in a film-ware tube with 1 ml of 90 percent acetone and kept at -20°C in darkness. Amounts of chlorophyll *a* and phaeopigments were determined with a Turner model 111 fluorometer using the method described by Holm-Hansen et al. (1965).

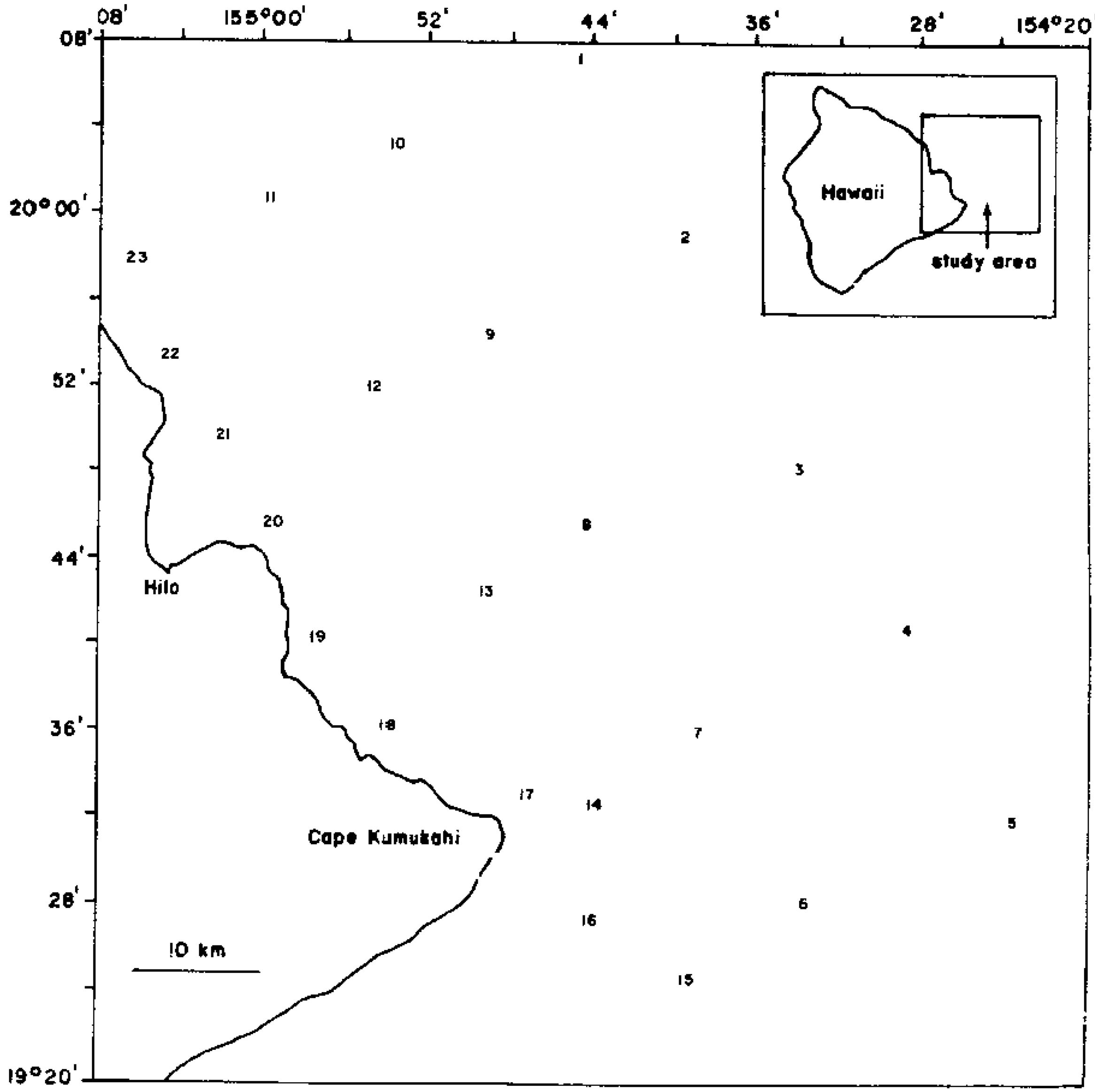

Figure 1. Location of XBT stations surveyed in waters off Hilo, Hawaii on February 5-6, 1983

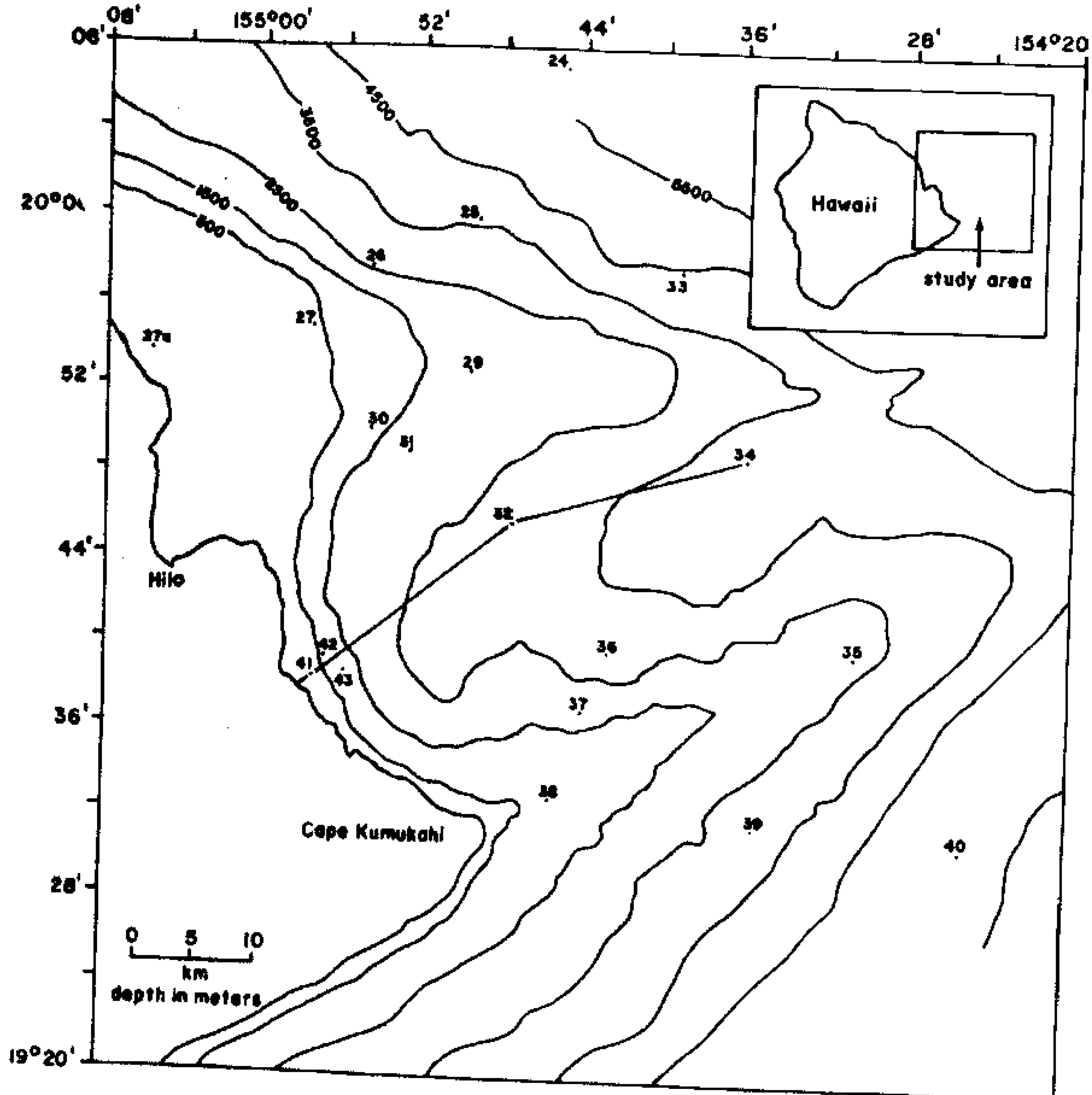

Figure 2. Location of oceanographic squid jigging stations, and ocean floor depth contours. Vertical profiles for stations along line perpendicular to shore are shown in Figures 5, 8, and 10.

Zooplankton Sampling

Sampling for zooplankton was carried out at 19 stations (Figure 2). Samples were collected by open vertical-net tows from 200 m and from the bottom of the mixed layer to the surface. The double net consisted of a 0.5-m diameter net of 0.183-mm mesh nylon and a 0.35-m diameter net of 0.035-mm mesh nylon with a 0.183-mm mesh inner net liner (see Hirota and Szyper, 1976, and Hirota et al., 1980, for further details). These samples were taken both during the night (stations 25, 26, 27, 29, 30, 31, 32, 36, 37, and 38) and during the day (stations 24, 33, 34, 35, 39, 40, 41, 42, and 43). Therefore, any apparent spatial patterns in plankton stocks are not based on synoptic collections, and the results are biased, in part, by animal behavior over a diel cycle (e.g., net avoidance, vertical migrations, and patchy aggregations).

The freshly collected net samples were processed at sea by taking an aliquot of each tow using a Folsom-type plankton splitter and filtering the aliquot onto a pre-weighted Whatman 47-mm GF/C glass fiber filter. Following this, the aliquot was briefly rinsed with a few milliliters of distilled water to remove interstitial and occluded salts and then stored in a desiccator and frozen at -20°C pending further processing. Upon returning to the laboratory, the frozen aliquots were dried at 60°C to constant weight as determined by at least two subsequent daily weights agreeing within 1 percent of each other. The final zooplankton abundance expressed in mg dry weights m^{-2} was computed from data on the aliquot fraction, the dry weights, the total and effective distances towed by the nets (efficiencies of the nets are estimated to be 95 percent for the 0.5-m net with a mouth area of 0.2 m^2 and 60 percent for the 0.35-m net with a mouth area of 0.1 m^2).

Squid Sampling

Three methods were used for sampling squids. The primary technique involved the use of 3 automatic squid jigging machines (Suzuki Tekko Co., Model Ikakko ST1C) and 6 high-intensity halogen lamps strung above the jigging machines. The 10 stations where automatic jigging machines were used (i.e., stations 25, 26, 27, 27A, 30, 31, 32, 36, 37, and 38) are shown in Figure 2. Most stations were surveyed for 3 hours during the night. About 60 jigs were placed 1 m apart on each monofilament line. Jigs were of 2 types: the akaika jig which is 107 mm long with 2 whorls of barbs (the outside barbs 16 mm long and the inside barbs 12 mm long); and the surumeika jig which measures 113 mm with a single whorl of barbs 11 mm in length. The 2 jigs were intermingled on the line, with about 2 times as many surumeika as akaika jigs used. At the bottom of the line, located 8 m below the bottom jig, was a 3 kg weight. The second method utilized single jigs attached to the fishing line of a standard rod and reel which was operated by hand. The third method, used at stations 28 and 29, involved the use of the *Hokusei Maru* midwater trawl (15 m by 15 m mouth opening, graded mesh, net length of 50 m) rigged for bottom work.

Captured squids were immediately measured and weighed. Then the reproductive state was determined and the stomach contents examined.

RESULTS AND DISCUSSION

Temperature, Salinity, and Currents

Only one feature stands out in the physical oceanographic data: surface salinity is low in a pattern which suggests that the source is groundwater discharge along the coast between Hilo and Cape Kumukahi. Figure 3 presents the surface salinity pattern of February 5-6, 1983 when the initial XBT survey was made, and Figure 4 the surface salinity pattern of February 7-10, 1983 when the oceanographic stations were surveyed (see Appendix A). Such temporal changes are not unexpected in this type of surface salinity pattern.

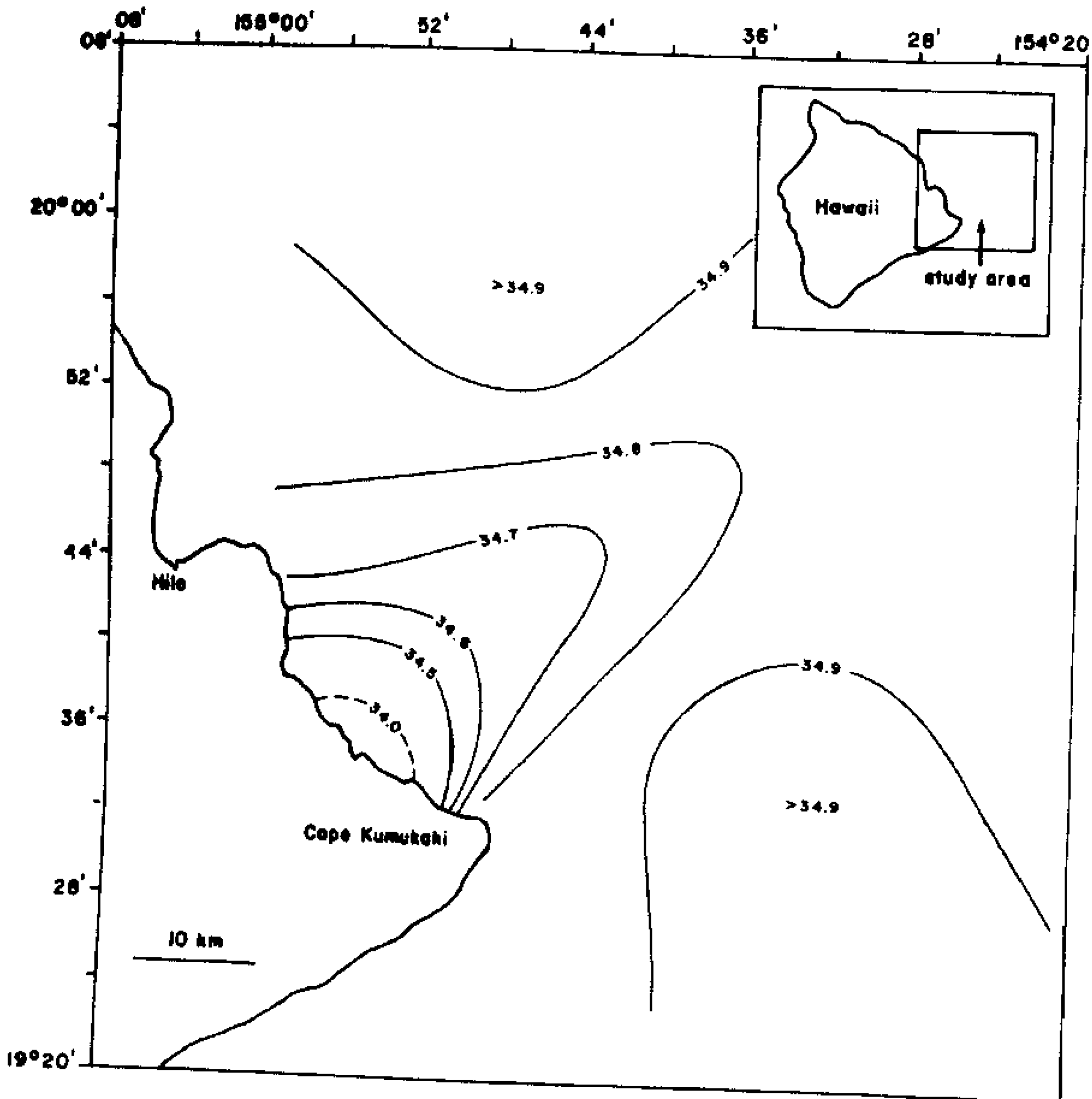

Figure 3. Surface salinity ($^0/oo$) off Hilo, Hawaii as determined from bucket samples of water taken during XBT survey, February 5-6, 1983

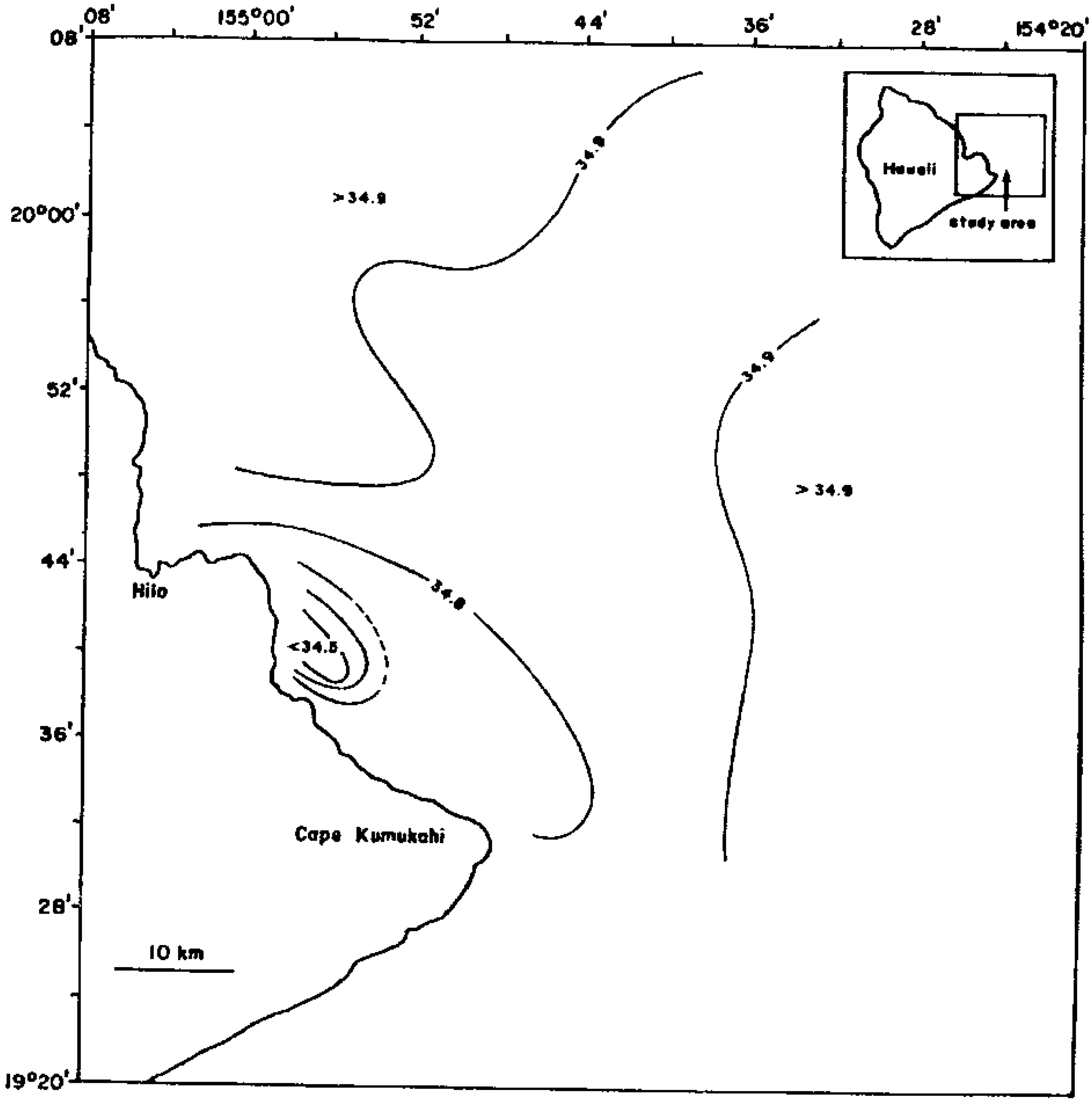

Figure 4. Surface salinity (°/oo) off Hilo, Hawaii as determined from bucket samples of water taken at oceanographic stations, February 7-10, 1983

Figure 5 presents a vertical profile of temperature and salinity. The profile was taken along the transect (shown in Figure 2) which was centered on the low-salinity tongue (shown in Figure 3). The hypersaline layer is less than 25 m thick near the coast, and, at the time of these observations, extended less than 16 km from shore. The 34.9 o/oo isohaline shows a broader and thicker region of slight dilution with fresh water within the surface layer.

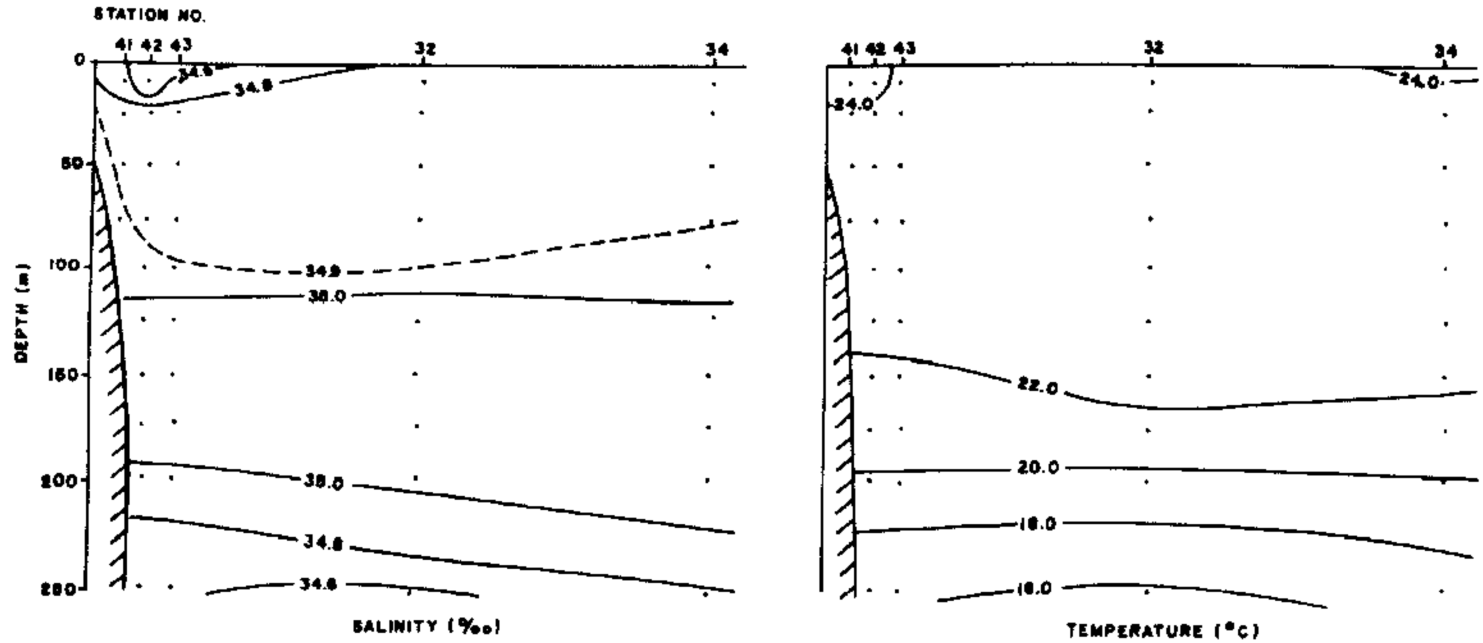

Figure 5. Profile of water salinity and temperature measurements taken along a line perpendicular to the coast, approximately along the axis of the Puna Canyon, February 8-9, 1983. Distance from Station 41 to Station 34 is 43 km.

The island boundary is very steep at the head of Puna Canyon, where the perpendicular line shown in Figure 2 intersects the shore. There are no apparent significant effects on temperature and salinity properties at depths below the surface layer. The thermocline is not distorted at the boundary, and the salinity-maximum layer near the top of the thermocline extends to the boundary with only a suggestion of thinning by mixing with fresher water above. This thinning may be a normal fluctuation unconnected with the freshwater influx; more observations are needed to determine this point. Vertical sample spacing near the depth of the salinity maximum was too broad to allow generation of clear contourable map of the maximum.

Nutrients

Analyses of surface nutrients showed an apparent enhancement by groundwater along the coast between Hilo and Cape Kumukahi during the initial XBT survey on February 5-6, 1983 (Figures 6 and 7). Silicate was more enhanced than nitrate plus nitrite (NO_3 plus NO_2). The silicate concentration in this region ranged from 12 to 22 μM while the average at the other stations was 2.9 μM. The nitrate plus nitrite concentration in the nearshore region ranged from an underdetectable level to 2.2 μM; the other stations averaged 0.016 μM.

Nitrate and nitrite and silicate values suggest nutrient input along the coast: in the surface layer, concentrations of NO_3 plus NO_2 are below the limit of detectability over most of the study area, but at the stations at the head of Puna Canyon, they are high. Vertical sections (Figure 8) indicate that the source of enrichment lies in the shoreline freshwater discharge, rather than in the upwelled water. Some surface enhancement of silicate and nitrate plus nitrite was also observed at the north side of the north ridge of Puna Canyon. The source of this enhancement is not apparent from the data, but this enhancement may represent a layer enriched by groundwater that has drifted off the coast.

The nutricline for nitrate plus nitrite was more distinct than for silicate in a water column of 250 m, as is common in Hawaiian water (Bienfang and Szyper, 1981). Positions of the nutricline in Puna Canyon were about 50 m shallower than those reported off Keahole Point (Bienfang and Szyper, 1981). The concentration of nitrate plus nitrite was below detectable limits from the 0 to 125 m depth at most stations, started increasing at the 150 m depth, and ranged between 2 and 5 μM at the 250 m depth. The deepest nutricline was observed at station 27 while the shallowest was observed at stations 42 and 43 over waters only 100 to 500 m deep.

Chlorophyll

All 19 stations showed a subsurface chlorophyll maximum between depths of 75 and 150 m. The mean depth for this maximum was 117 m (standard deviation: 24 m) with a mean chlorophyll *a* concentration of 0.135 mg m^{-3} (standard deviation: 0.046 mg m^{-3}). The concentration at the subsurface chlorophyll maximum layer was about 3 times higher than at the surface (0.0573 mg m^{-3}; standard deviation: 0.026 mg m^{-3}). The general characteristics of vertical distribution of chlorophyll *a* were found to be very similar to those observed elsewhere along the Hawaiian Archipelago (Hirota et al., 1980). A seasonal study at a deep oceanic station (about 1,300 m deep at 19°55'N, 156°10'W) about 12 miles off Keahole Point, on the western coast of the island of Hawaii, showed a relatively shallower depth (85 m; standard deviation: 9 m) of the subsurface chlorophyll maximum with a higher chlorophyll *a* concentration (0.31 mg m^{-3}; standard deviation: 0.12 mg m^{-3}; Bienfang and Szyper, 1981).

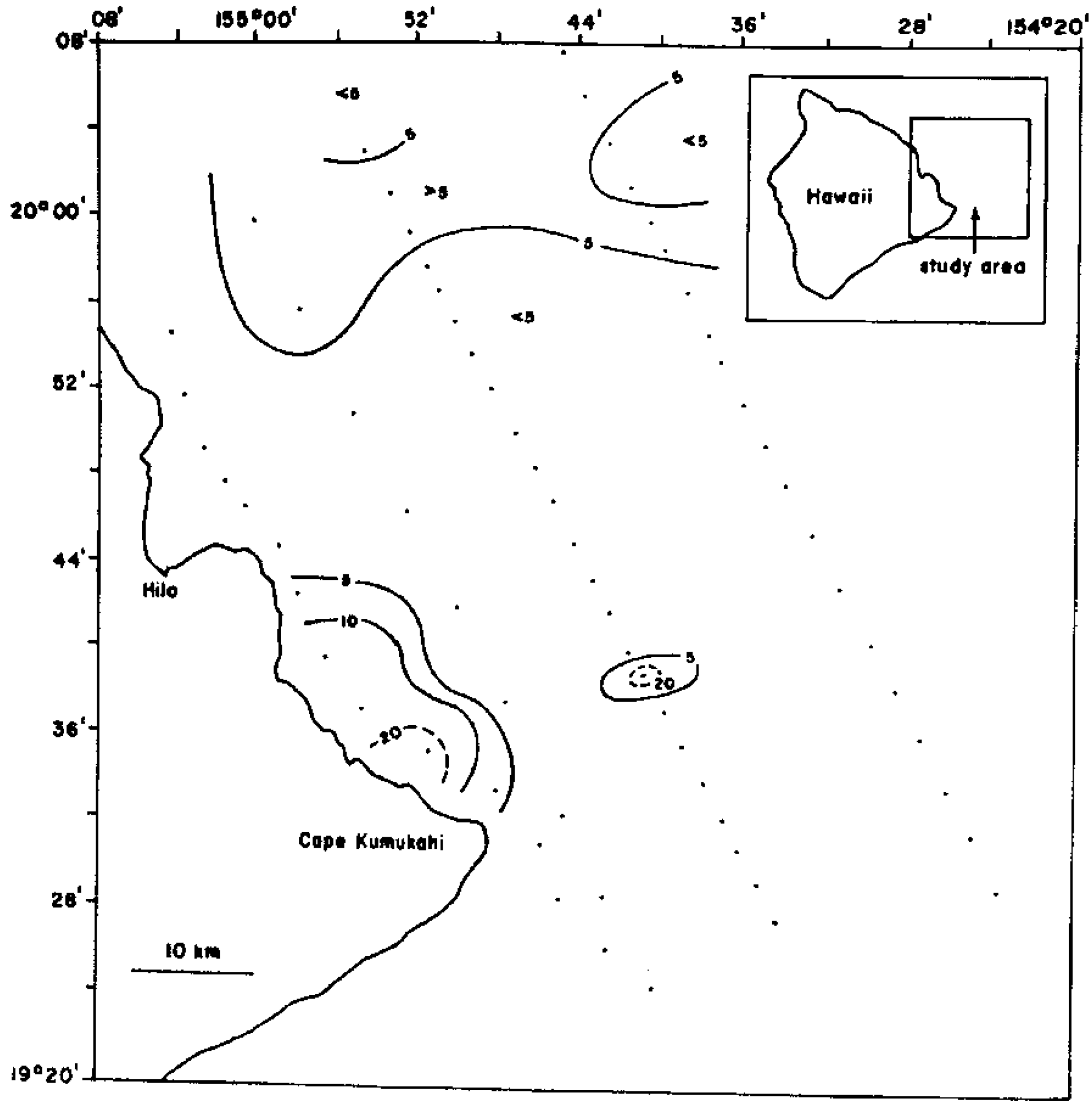

Figure 6. Surface silicate (μM) concentration along the coast between Hilo and Cape Kumukahi as determined by bucket sample during XBT survey, February 5-6, 1983

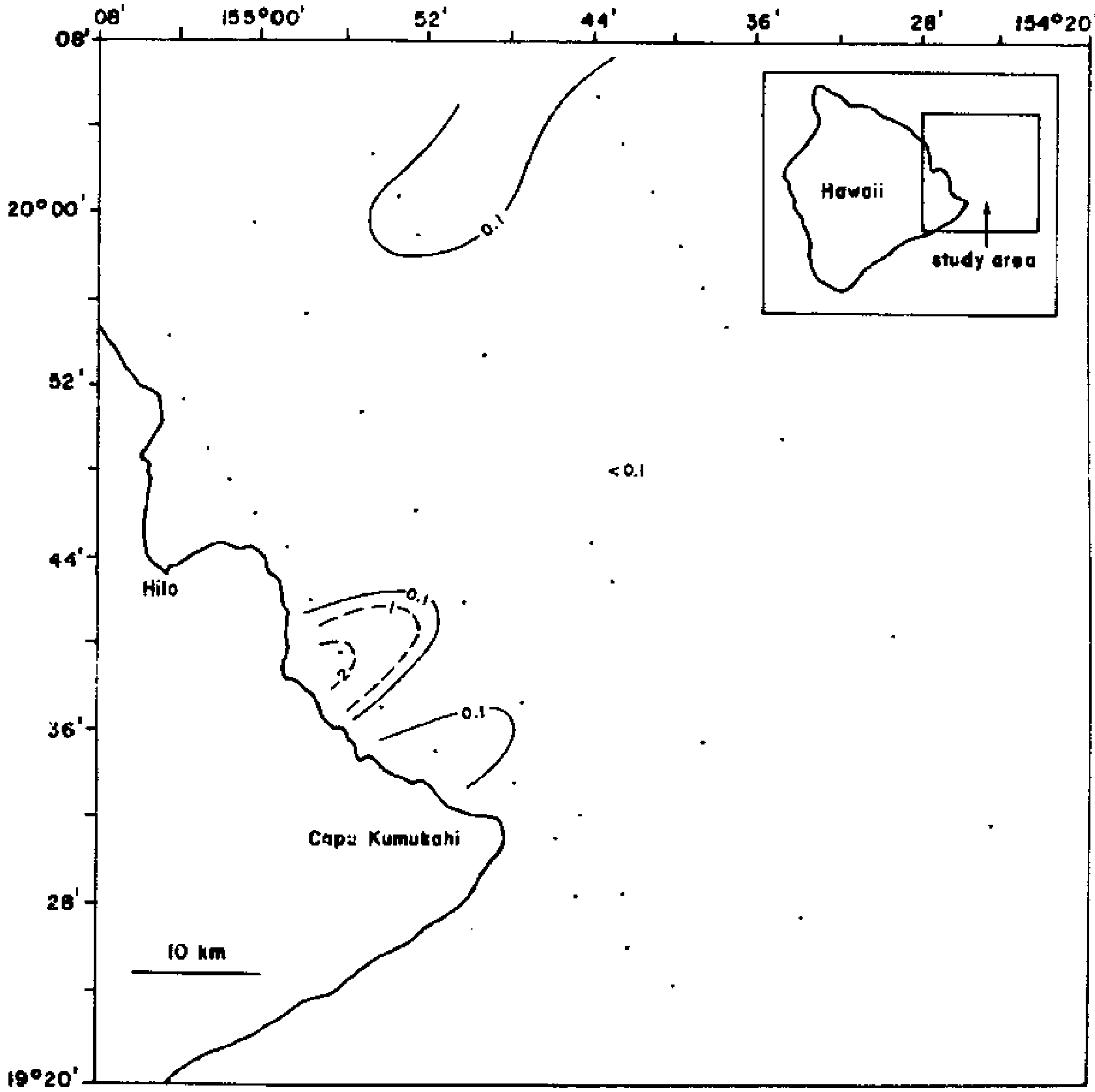

Figure 7. Surface nitrate plus nitrite concentrations (μM) along the coast between Hilo and Cape Kumukahi as determined by bucket samples during XBT survey, February 5-6, 1983

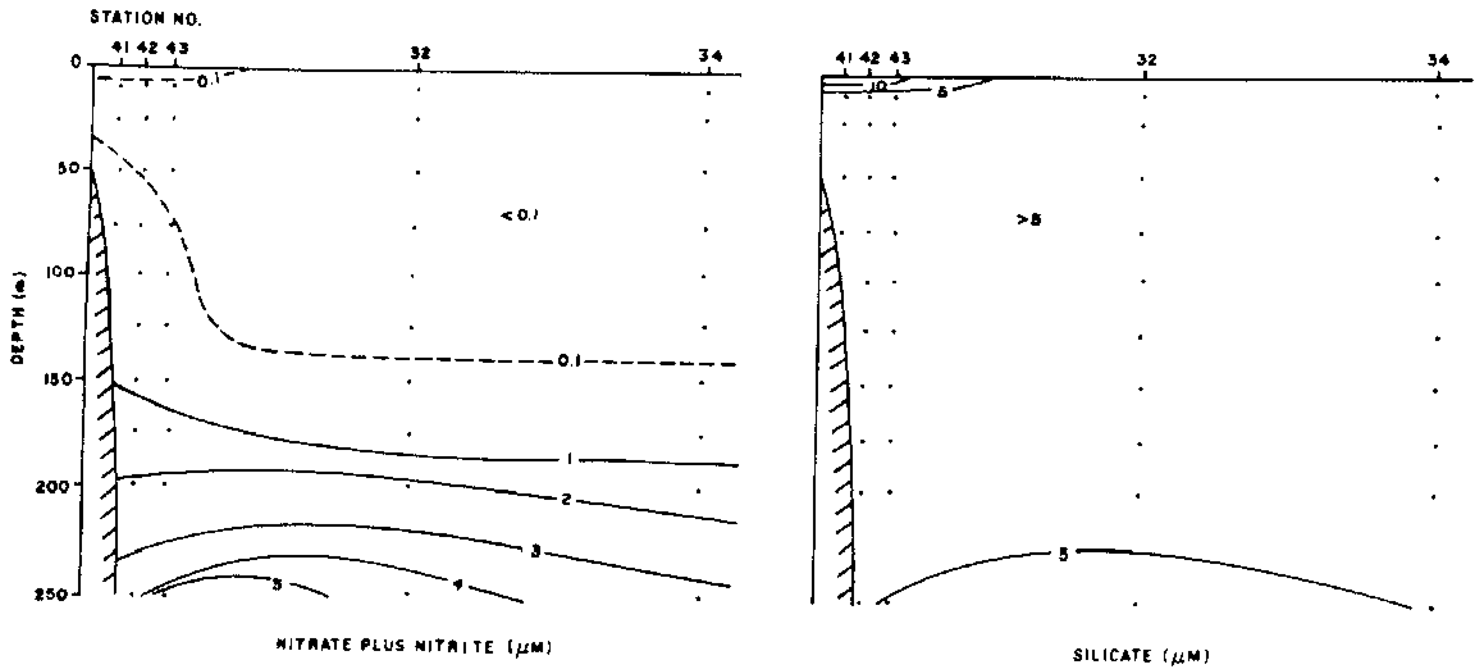

Figure 8. Nitrate plus nitrite and silicate concentrations observed along a line perpendicular to the coast, approximately along the axis of the Puna Canyon, February 8-9, 1983. The distance from station 41 to station 34 is 43 km.

Chlorophyll *a* concentration at the surface was higher along the coast, with a strong tongue along the north ridge of Puna Canyon (Figure 9). The island effect was apparent at stations 41 and 42, where the chlorophyll *a* concentration at the subsurface chlorophyll maximum layer was higher than 0.2 mg m^{-3} (Figure 10). However, the nutrient enrichment was only obvious at the surface (8 to 10 μM Si^{-1} compared with 2 to 3 μM Si^{-1} at greater depths). Possible mechanisms for this phenomena include: (1) adsorption of nutrients by phytoplankton in surface waters without increased production of chlorophyll *a*; and (2) adsorption of nutrients by phytoplankton in surface waters which are transported to greater depths (light at about 1 percent of surface intensity) by vertical mixing and/or sinking where they then produce chlorophyll *a* with stored nutrients.

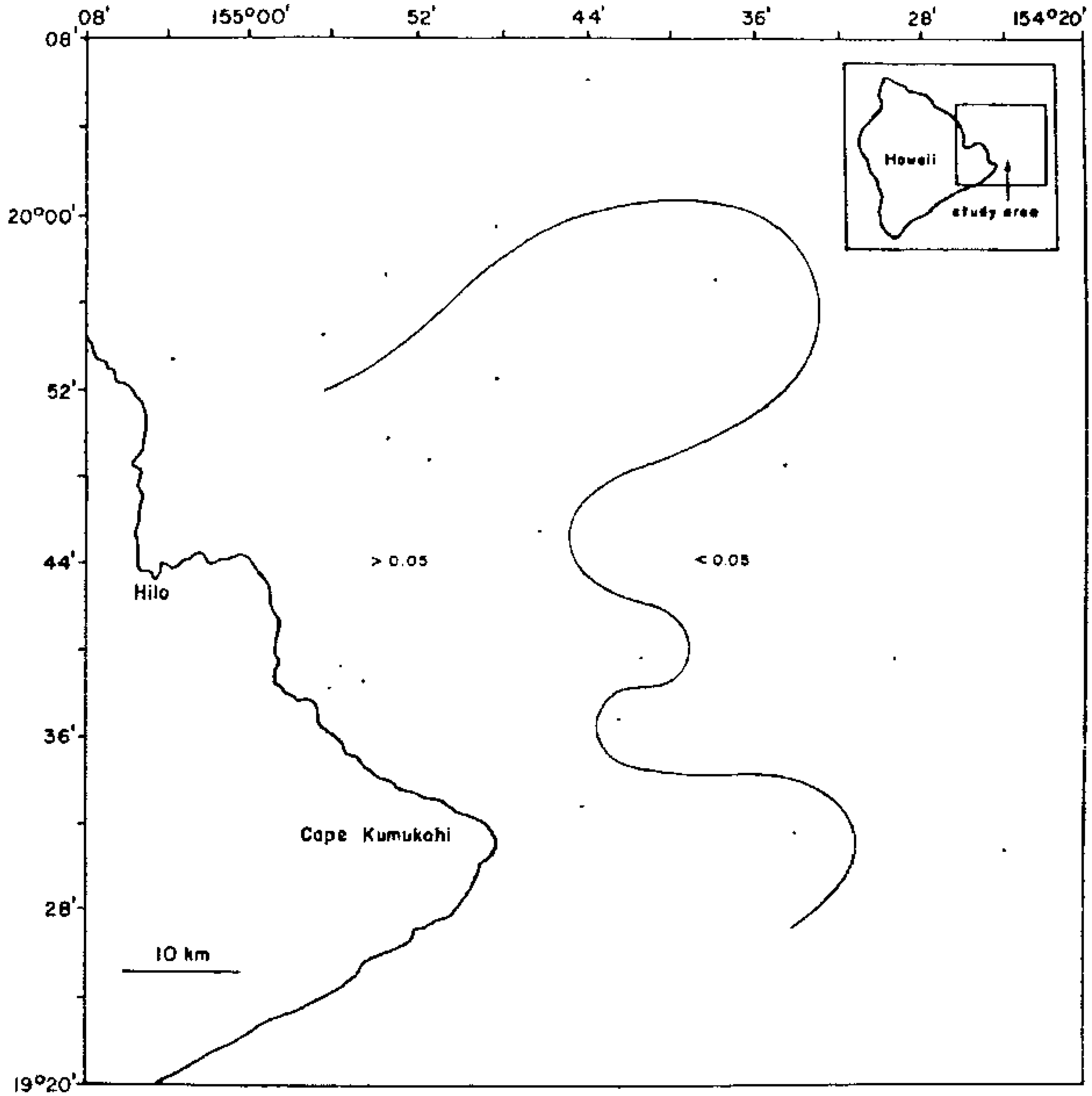

Figure 9. Surface chlorophyll *a* concentrations (mg m^{-3}) along the coast between Hilo and Cape Kumukahi as determined from bucket samples of water taken at oceanographic stations, February 7-10, 1983

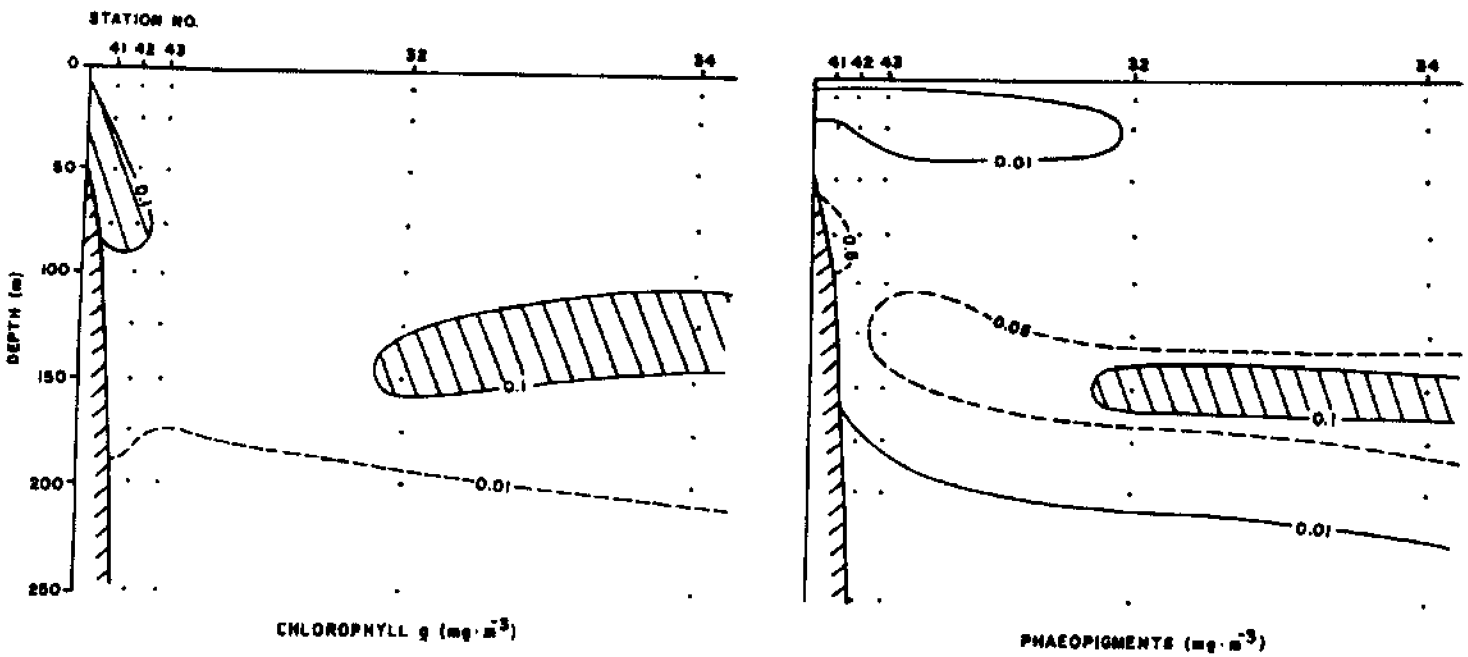

Figure 10. Chlorophyll *a* concentrations and phaeopigments observed along a line perpendicular to the coast, approximately along the axis of the Puna Canyon, February 8-9, 1983. The distance from station 41 to station 34 is 43 km.

A relatively shallow surface mixed layer was observed along the coast between Cape Kumukahi and Hilo. In this region, especially at stations 41 and 42, the depths of the deep chlorophyll maximum layer and 1 percent light level were shallow, and a strongly developed chlorophyll maximum was present (Appendix D). However, the standing crop of chlorophyll *a* calculated for a 200-m deep water column was not necessarily high at those stations. High standing crop of chlorophyll *a* (>15 mg m^{-2}) was observed in water above both sides of the south ridge of Puna Canyon (Figure 11). The average standing crop of chlorophyll *a* was 13 mg m^{-2} (standard deviation: 2 mg m^{-2}), which was slightly higher than that of 10 mg m^{-2} observed along the Hawaiian Archipelago (Hirota et al., 1980).

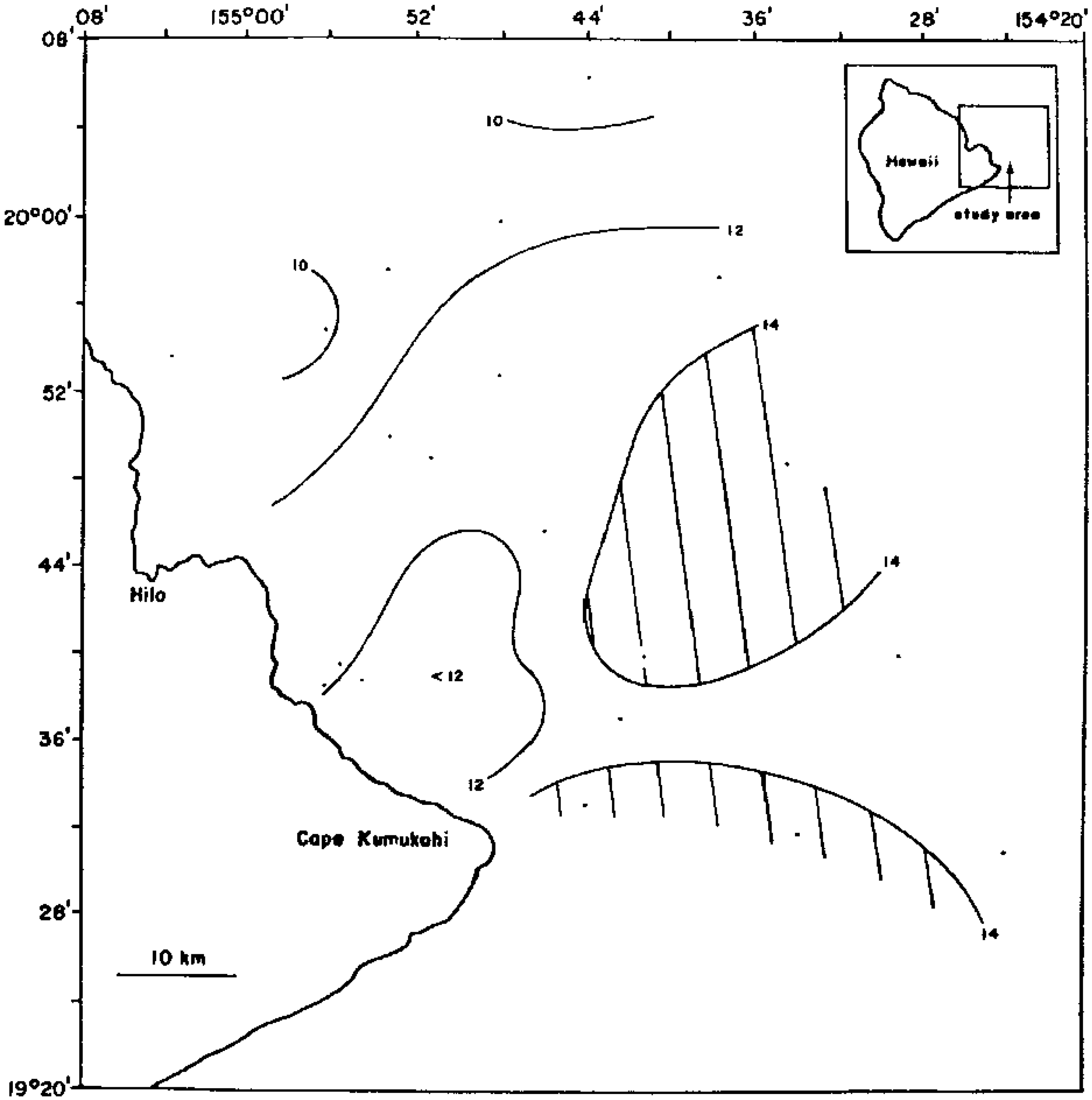

Figure 11. Spatial distribution of chlorophyll *a* integrated from the surface to 200 m depth (mg m^{-2}), February 7-10, 1983

Zooplankton

The spatial distribution of macrozooplankton stocks in the upper 200 m during the sampling period (Figure 12) shows that the abundances are relatively low at this time of the year, 500 to 1,000 mg m^{-2}. The average macrozooplankton stock of about 800 mg m^{-2} is slightly below the average value observed in Hawaiian waters of about 900 mg m^{-2} (Hirota et al., 1980). There are two high abundance areas: the north side of the north ridge of Puna Canyon (stations 25 through 27 and 33) and the south side of the head of Puna Canyon (stations 36 through 38 and 41 through 43). Microzooplankton abundance was somewhat similar in areal distribution (Figure 13).

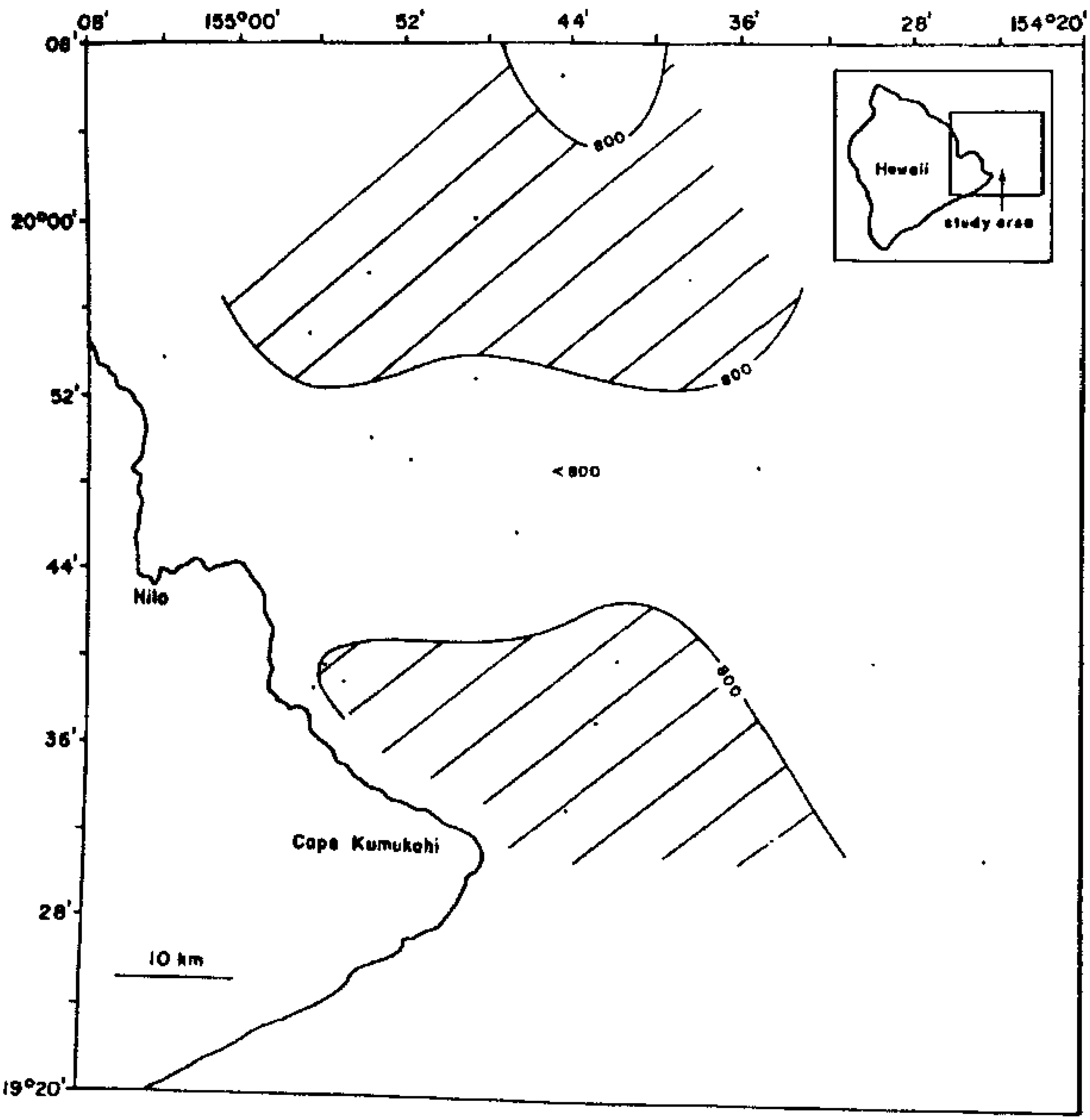

Figure 12. Spatial distribution of macrozooplankton abundance (mg dry weight m^{-2}) in the upper 200 m, February 7-10, 1983

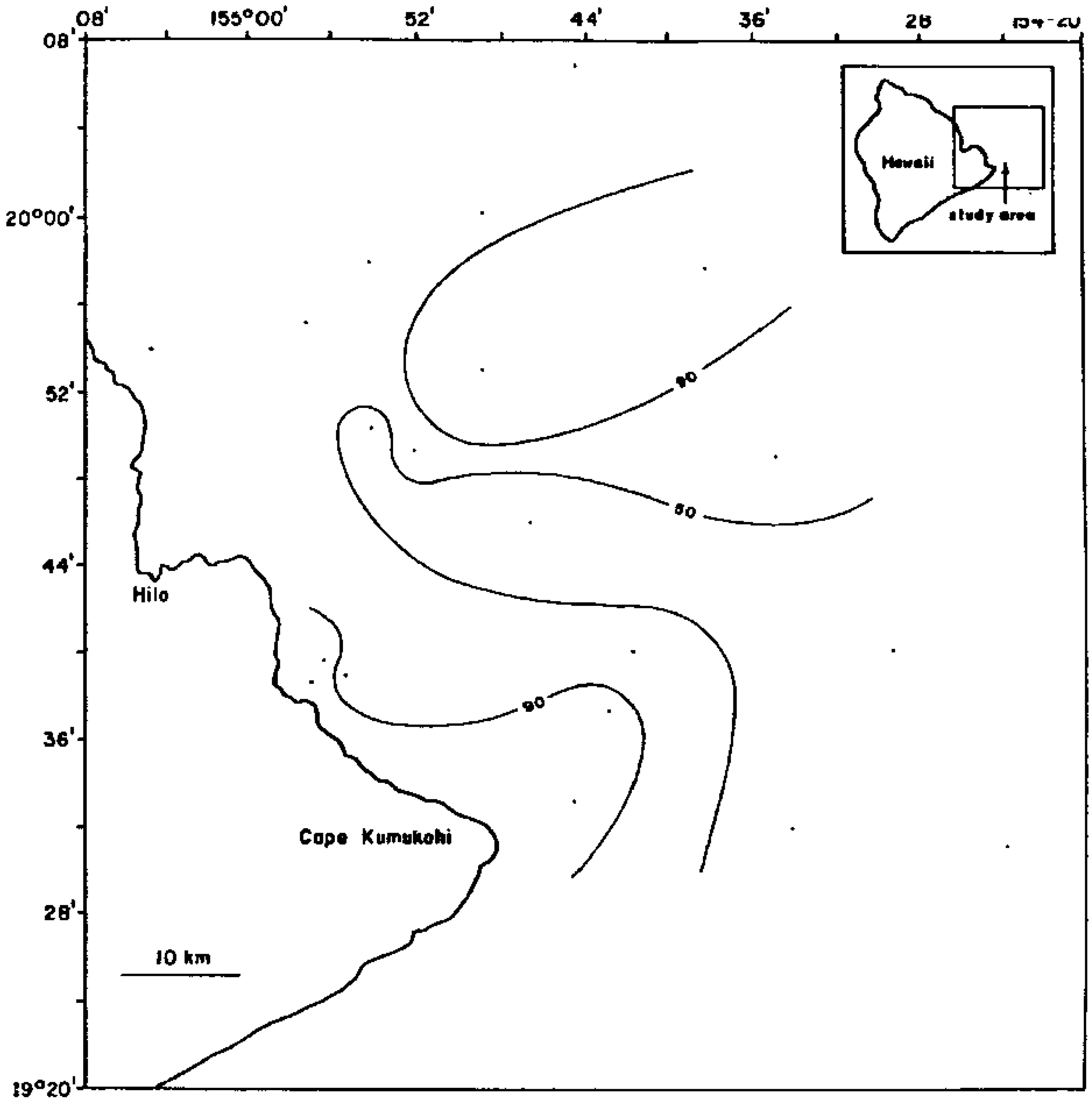

Figure 13. Spatial distribution of microzooplankton abundance (mg dry weight m^{-2}) in the upper 200 m, February 7-10, 1983

Squid

The only squid captured on jigs or handlines was the oceanic squid *Sthenoteuthis oualaniensis* (Lesson) which occurs throughout the central Pacific and Indian Oceans (Wormuth, 1976). Yuen (1979) reported that the squid captured in the ika-shibi fishery is the more inshore relative, *Nototodarus hawaiiensis*. Local fishermen have indicated that some squid may be seasonal in these waters. *N. hawaiiensis* is known to reside on the ocean floor at depths of a few hundred meters during the day (Young, 1978). Two tows were made with the bottom trawl at station 28 in approximately 385 m of water during the day to determine if *N. hawaiiensis* was present. Since the bottom in this area is not suitable for trawling, the ship's captain chose to tow the net just above the bottom. On the first tow, however, the net touched bottom at least once, as evidenced by the catch and the considerable damage to the net. During this tow 15 specimens of *N. hawaiiensis* ranging in size from 43 to 160-mm mantle length were captured (Appendix E). Two of the six females were sexually mature, as were five of the eight males (sex was undetermined for one specimen). The second tow did not touch the bottom and no squid were caught. *N. hawaiiensis* was clearly present in the area during leg II even though it was not caught at the nighttime jigging stations. Whether or not this species occurs in greater abundance and/or is attracted to the night lights during other seasons of the year is uncertain. Nevertheless, we suspect that much, at least, of the ika-shibi fishery is based on *Sthenoteuthis oualaniensis* rather than *N. hawaiiensis*.

The total number of squids caught off Hilo was 507, of which 17.9 percent were males and 82.1 percent females (Appendices F and G). Such female-dominated sex ratios are common for jig-captured ommastrephid squids. The reasons for this, however, are unknown. Forty-nine percent of the males and 43 percent of the females were mature; 84 percent of the females had mated. Average catch rates of 35.1 squid/hour in the three northernmost stations were considerably higher than those encountered in the previous cruises. The size-frequency distribution of all females captured shows a bimodal pattern (Figure 14); the smaller males lacked the larger size mode. One mode is centered at about 150-mm mantle length and the other at about 250-mm mantle length. The size-frequency data are presented graphically for each station in Figure 15. This figure demonstrates that the bimodal distribution results from geographical differences in the size of squid captured (see also Figure 16). In the northern transect (stations 25 through 27) the average catch per station in the 100 to 199-mm mantle length category was 10.2 specimens/hour of jigging while in southern stations 30 through 38 the average catch in this size category was 13.5 (this difference is not significant, $P > 0.1$). (This and the following statistical analyses were conducted using the Wilcoxon 2-sample test.) For the larger-sized squid (200 to 300-mm mantle length) the average catch per station in the northern transect was 26.6 while in the southern stations the average catch in this size range was 1.0 (this difference is significant, $P < 0.025$). At the most inshore station, 27A (depth approximately 160 m), no squid were seen or captured.

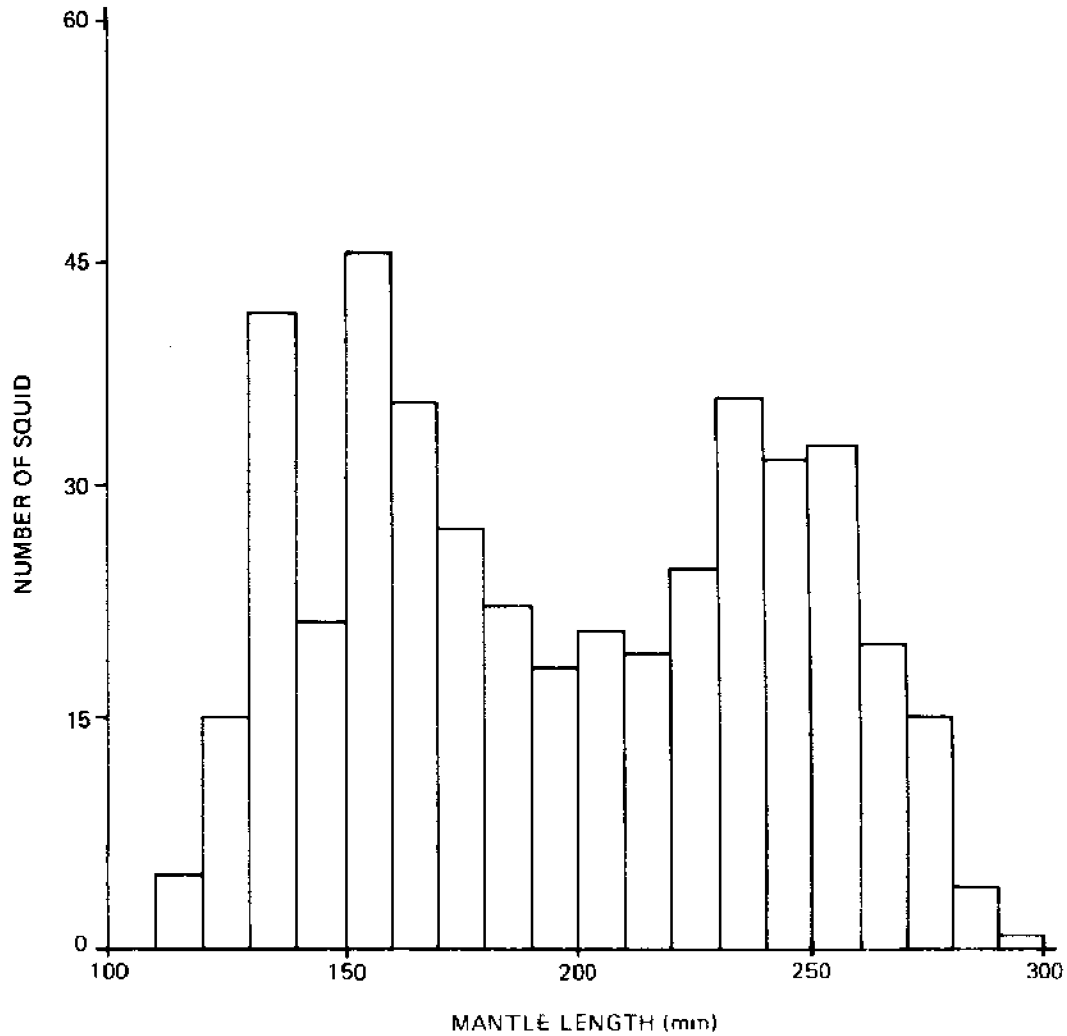

Figure 14. Size-frequency of all *Sthenoteuthis oualaniensis* females captured at 10 stations (n = 433)

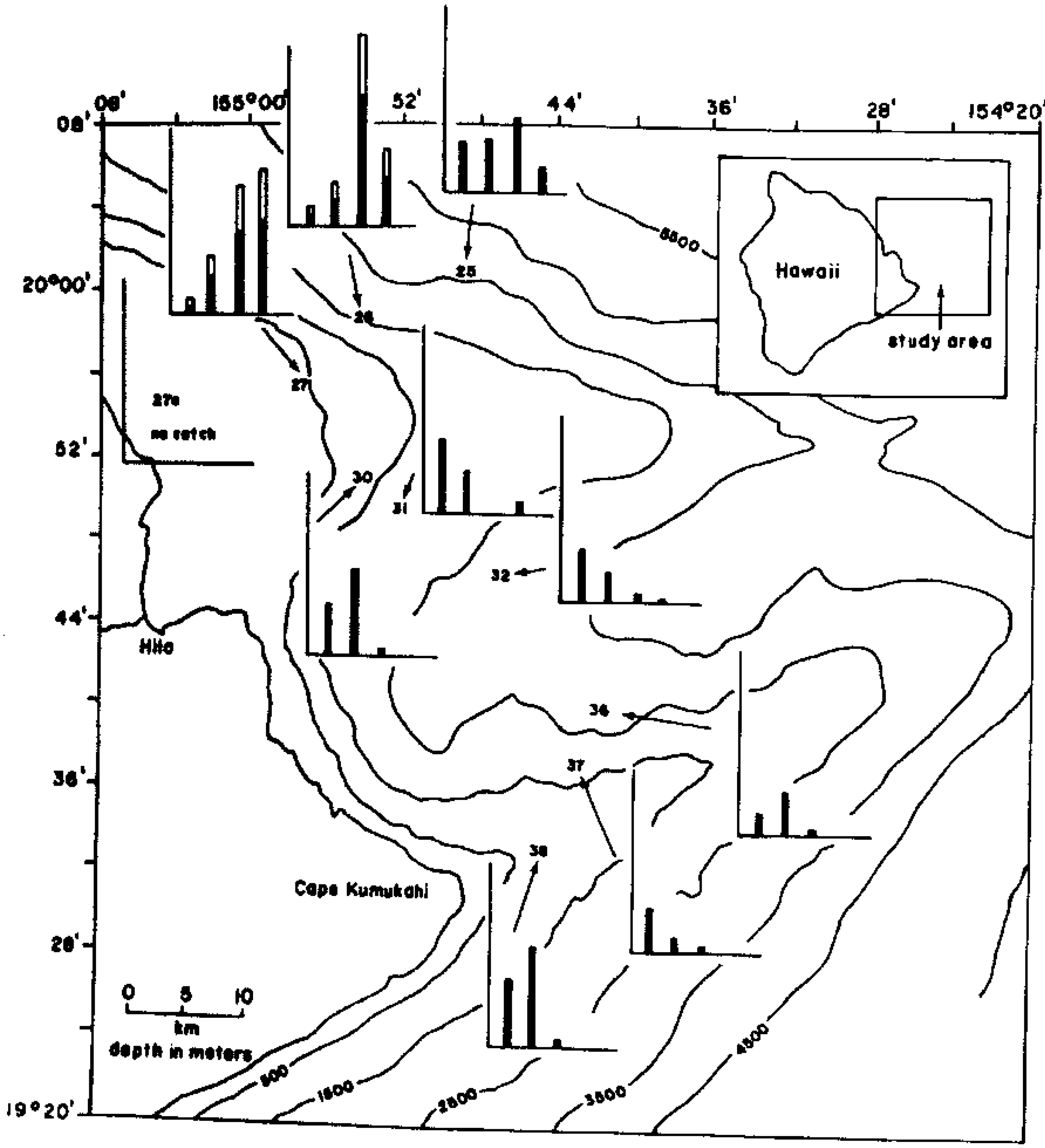

Figure 15. *Sthenoteuthis oualaniensis* size-classes at each jigging station. Y-axis: Numbers of squids. Height of axis represents 70 squids. X-axis: Squid size classes; 100 to 149 mm mantal length (ML), 150 to 199 mm ML, 200 to 249 mm ML, 250 to 299 mm ML (left to right). Black bars are actual catches per 3 hours of jigging. White bars are corrected catches where fishing effort was less than 3 hours.

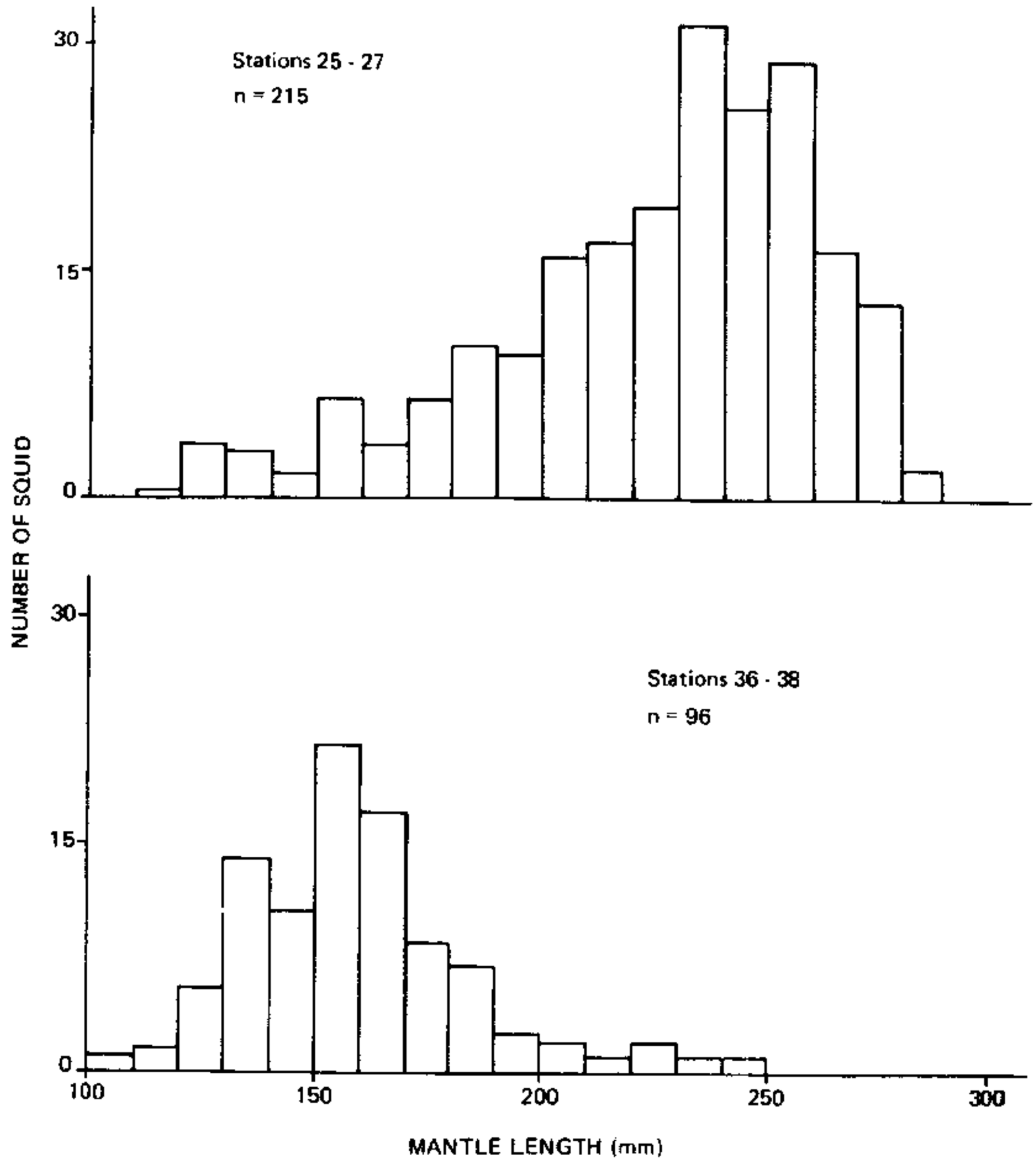

Figure 16. Size-frequency of *Sthenoteuthis oualaniensis* females

The analyses of the squid stomach contents also revealed some clear trends (Figure 17). At the four northernmost stations where squid were captured (i.e., stations 25, 26, 27, and 30) the number of squid with crustaceans in their stomachs relative to the number with fish in their stomachs was 1.22 while at the four southern stations the ratio was 0.20. This difference is significant ($P < 0.05$). Station 31, situated geographically between the northern and southern groups, had a ratio of 0.48. In previous studies around the Hawaiian islands we found that squids ate predominantly fish. In the northern areas off Hilo the squids, clearly, have an unusual diet. The dominant crustacean in the stomach was the midwater, vertically migrating shrimp *Oplophorus* sp. The highest percentage of squid with empty stomachs was found at station 27. Although not quantified, most squids that had food in their stomachs at this station had very little. We suspect that the prey of the squid are scarce in such shallow waters (bottom was 385 m).

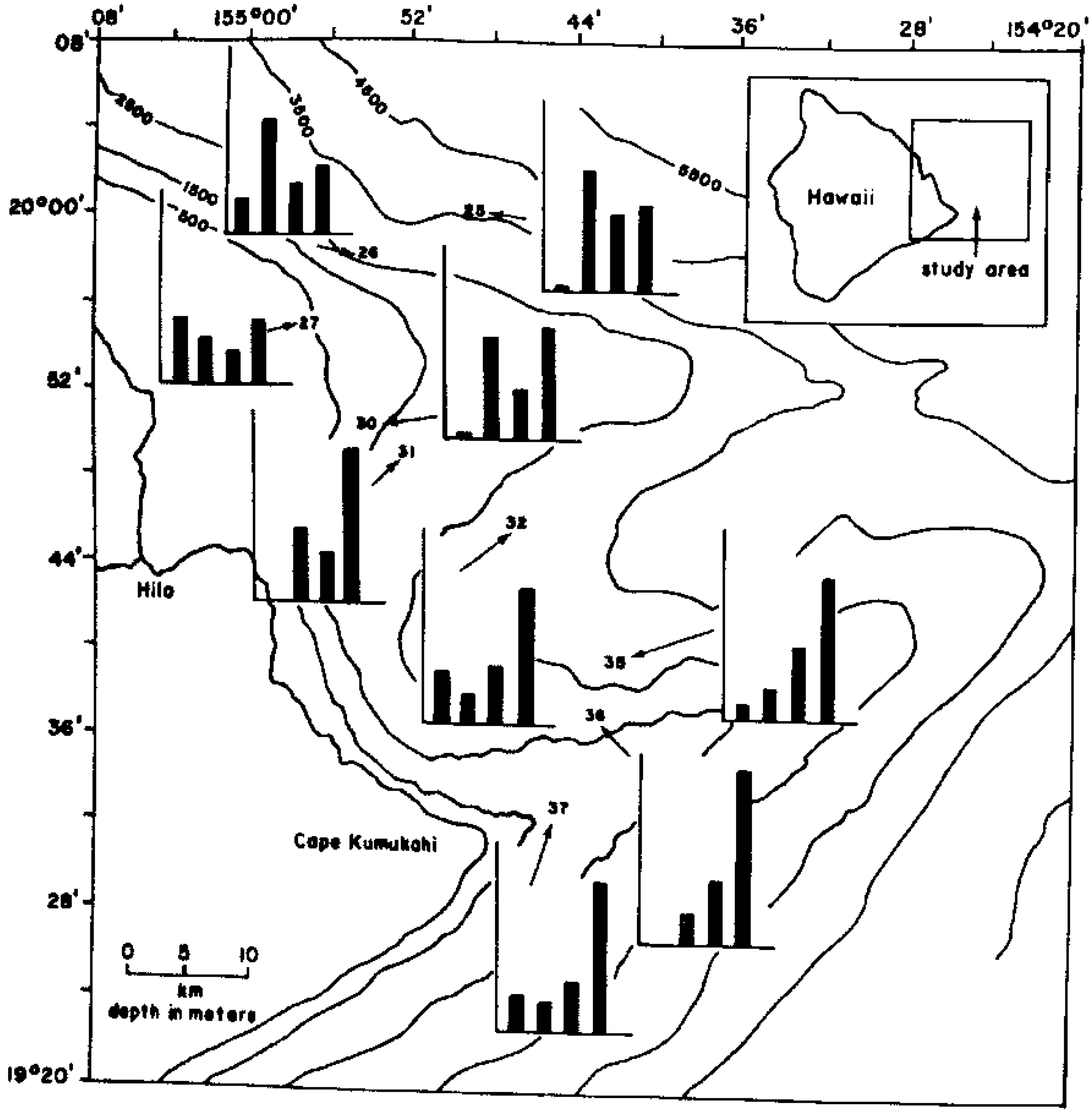

Figure 17. *Sthenoteuthis oualaniensis* stomach contents. Y-axis: Percentage of animals examined that contained a given food category. Height of axis represents 70 percent. X-axis: Food category; empty, crustacean remains, cephalopod remains, fish remains (left to right). A category of unidentified remains was not included as it represented only 0.01 percent of the total. The number of stomachs examined at each station ranged from 26 to 48.

Many of the squid fragments found in the squid stomachs at all stations were *Sthenoteuthis oualaniensis* remains. Consumption of these remains probably resulted from attacks on squid that were damaged by the jigging machines and/or from eating floating fragments (especially tentacles) that tore off the squid during the jigging operations rather than from true cannibalism. Other squids found in the stomach included *Abraliopsis* sp., *Enoploteuthis* sp., *Onychoteuthis* sp., and possibly *Chiroteuthis* sp.

SUMMARY

Our findings can be summarized as follows:

1. No strong geostrophic currents are indicated by the data. This conclusion is supported by ship-drift observations. A short survey in an area with weak and variable currents cannot hope to determine whether or not persistent patterns of tidal currents or net flow are present. Efforts should be made to work with fishermen on this.

2. Nutrient input from shoreline freshwater discharge was observed at the head of the Puna Canyon.

3. Although some enhancement of surface chlorophyll *a* concentration was observed at the head of the Puna Canyon, the average standing crop of chlorophyll *a* (0 to 200 m) was within the range observed along the Hawaiian Archipelago. The average macrozooplankton stock was also similar to those typical of the Hawaiian Archipelago.

4. The total number of squid caught was unusually high in the northern stations. Distinct difference in the size distribution of female squid was observed between the northern transect (stations 25 through 27) and the southern transect (stations 36 through 38), with large specimens being virtually restricted to the northern stations. The analyses of the squid stomach contents also revealed significant geographical difference between these transects. The midwater shrimp, *Oplophorus* sp., was common in stomachs of northern but not in those of southern squid.

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APPENDICES

Appendix A. Results of surface water analysis for nitrate plus nitrite and silicate taken by bucket sample during XBT survey. February 5-6, 1983

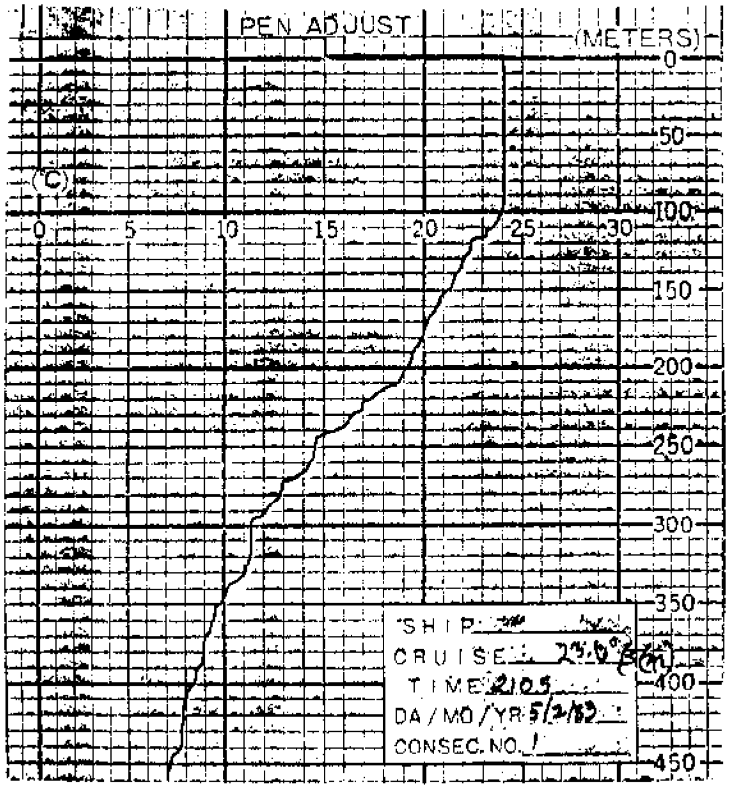
Transect Station	Nitrate plus Nitrite (μM)	Silicate (μM)
1	0.100	7.782
2	0.058	5.331
3	ud*	4.390
4	0.062	4.787
5	0.033	5.193
6	ud	5.064
7	ud	3.976
8	0.029	1.486
9	ud	4.264
10	0.038	2.458
11	0.002	2.042
12	ud	1.353
13	ud	2.322
14	ud	2.100
15	ud	1.891
16	0.004	0.581
17	ud	1.975
18	—	1.778
19	0.001	1.807
20	ud	2.098
21	ud	1.980
22	ud	1.911
23	0.022	1.884
24	0.006	1.834
25	ud	1.833
26	ud	2.521
27	ud	7.364
28	0.001	2.949
29	0.011	2.992
30	ud	3.064
31	ud	1.714
32	ud	2.389
33	0.006	2.309
34	ud	1.724
35	ud	1.541
36	ud	1.612
37	0.011	1.498
38	0.002	1.499
39	0.010	2.327
40	0.140	5.714
41	0.164	7.252
42	ud	4.561
43	ud	6.735
44	ud	6.439
45	ud	2.037
46	ud	2.497
47	0.008	2.327
48	ud	1.436

*ud = under detectable

Transect Station	Nitrate plus Nitrite (μM)	Silicate (μM)
49	ud	1.686
50	0.015	1.491
51	ud	1.476
52	ud	1.836
53	ud	2.202
54	0.035	2.210
55	0.038	2.979
56	0.543	22.26
57	ud	11.928
58	2.170	16.35
59	ud	5.655
60	0.067	2.836
61	0.083	2.035
62	0.016	2.728
63	0.001	2.034
64	0.023	2.070
65	ud	1.990
Numbers	61	61
Mean	0.016	2.912
Standard Deviation	0.033	1.730

Appendix B. XBT Profiles

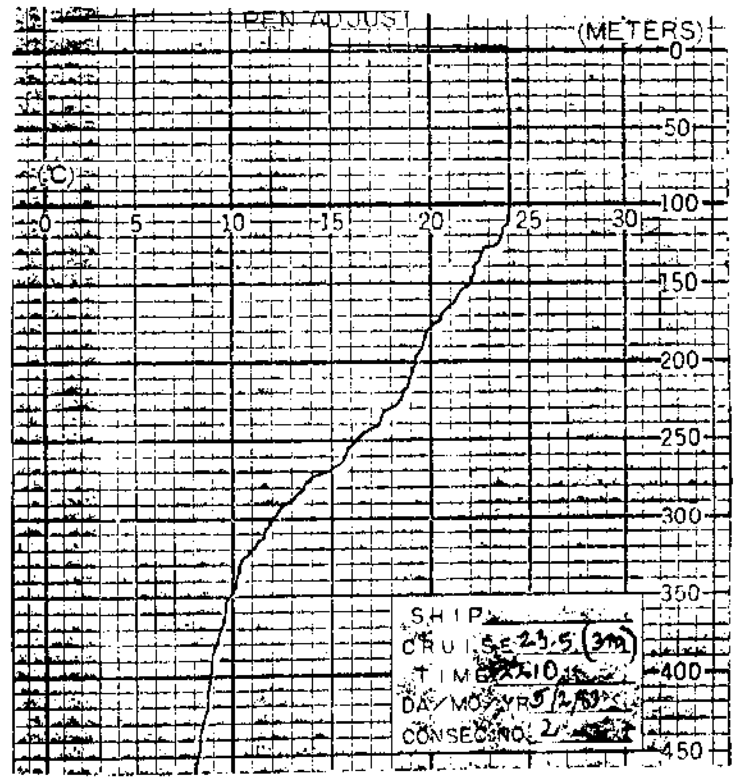
Station 1



20°07.2'N Feb. 5, 1983
154°44.8'W 2105 hr

Surface Temperature 23.6°C

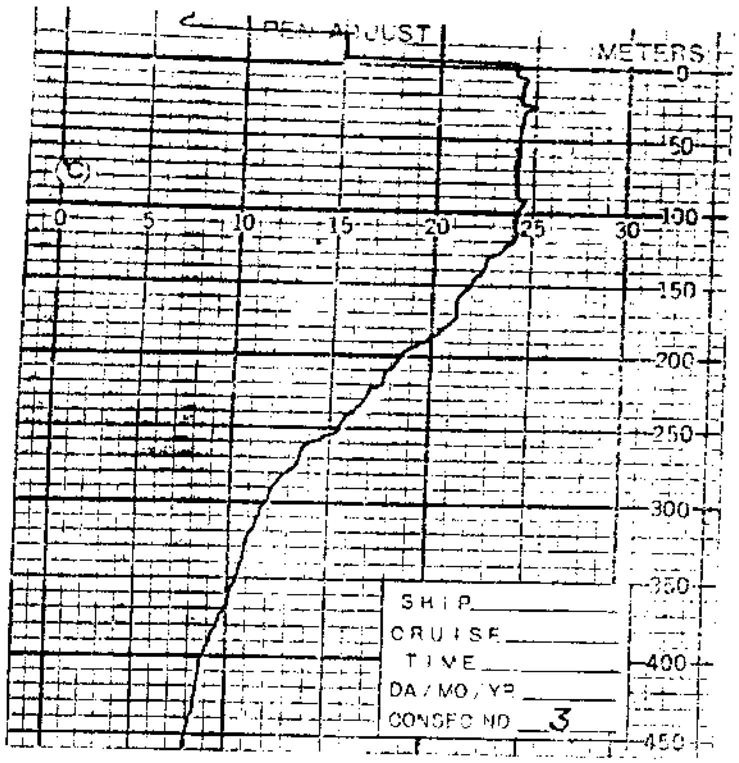
Station 2



19°58.3'N Feb. 5, 1983
154°40.4'W 2210 hr

Surface Temperature 23.5°C

Station 3

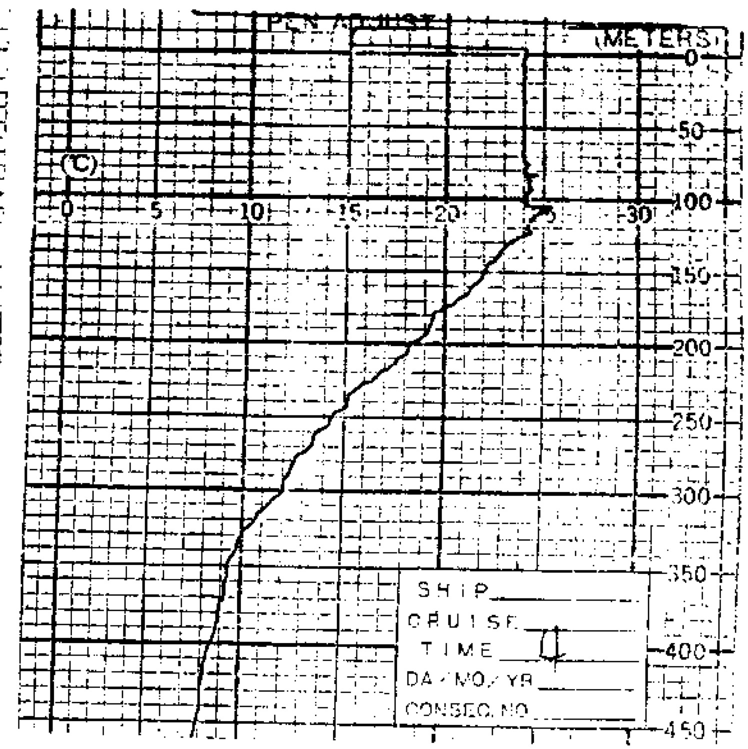


19°49.5′N
154°35.5′W

Feb. 5, 1983
2300 hr

Surface Temperature 23.6°C

Station 4

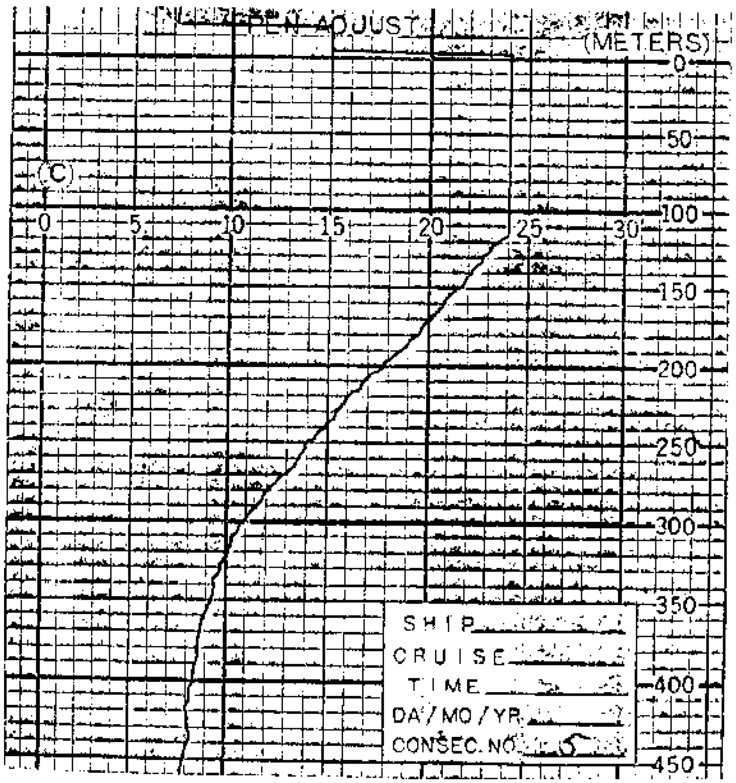


19°40.5′N
154°30.5′W

Feb. 6, 1983
0006 hr

Surface Temperature 23.4°C

Station 5

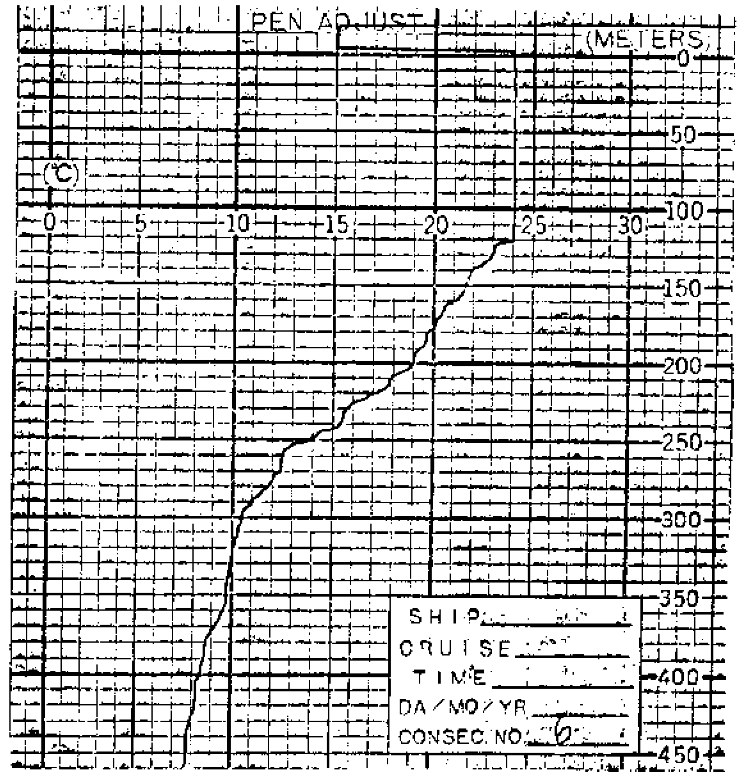


19°31.7'N
154°25.5'W

Feb. 6, 1983
0106 hr

Surface Temperature 23.4°C

Station 6

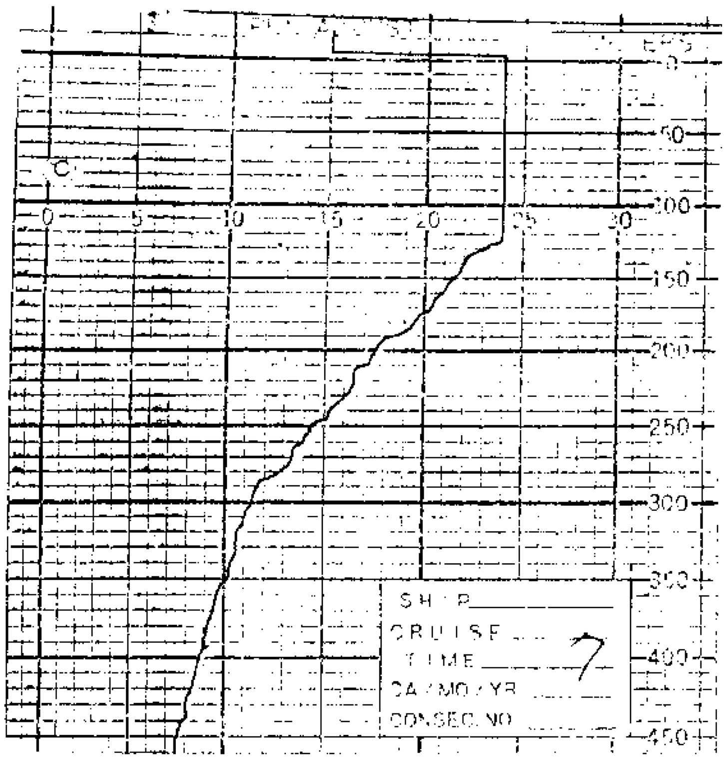


19°27.8'N
154°35.0'W

Feb. 6, 1983
0154 hr

Surface Temperature 23.6°C

Station 7

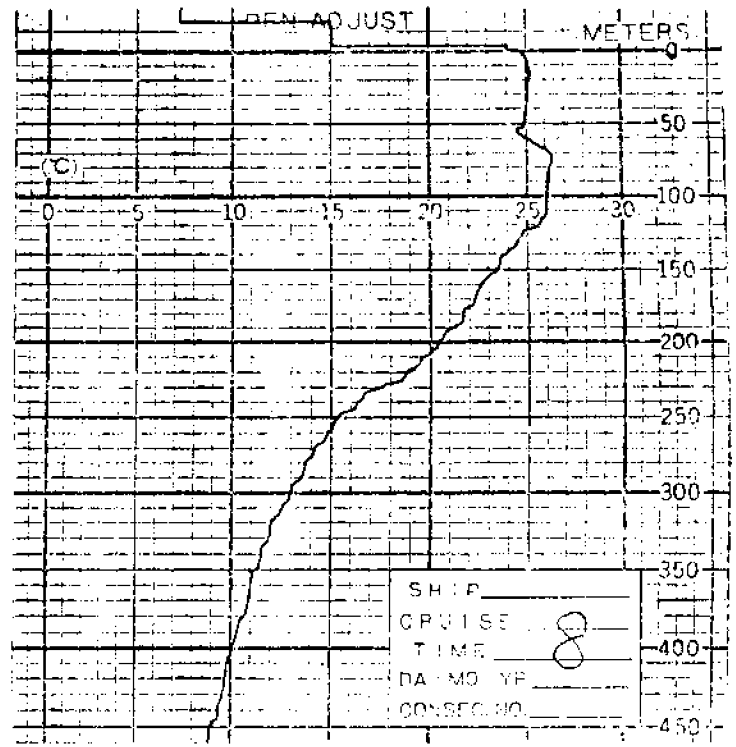


19°35.8'N
154°39.6'W

Feb. 6, 1983
0254 hr

Surface Temperature 23.6°C

Station 8

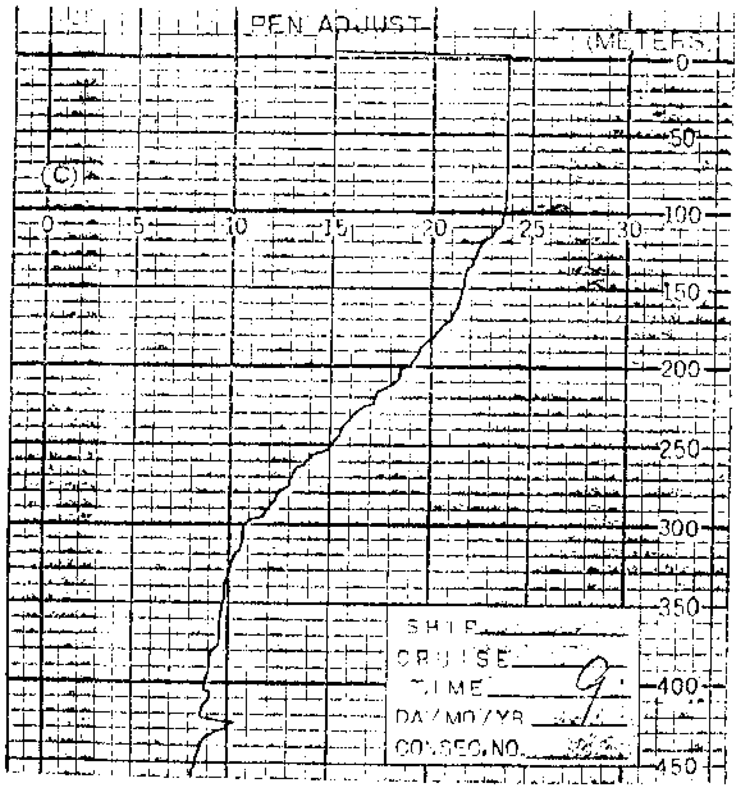


19°44.7'N
154°44.7'W

Feb. 6 1983
0348 hr

Surface Temperature 23.5°C

Station 9

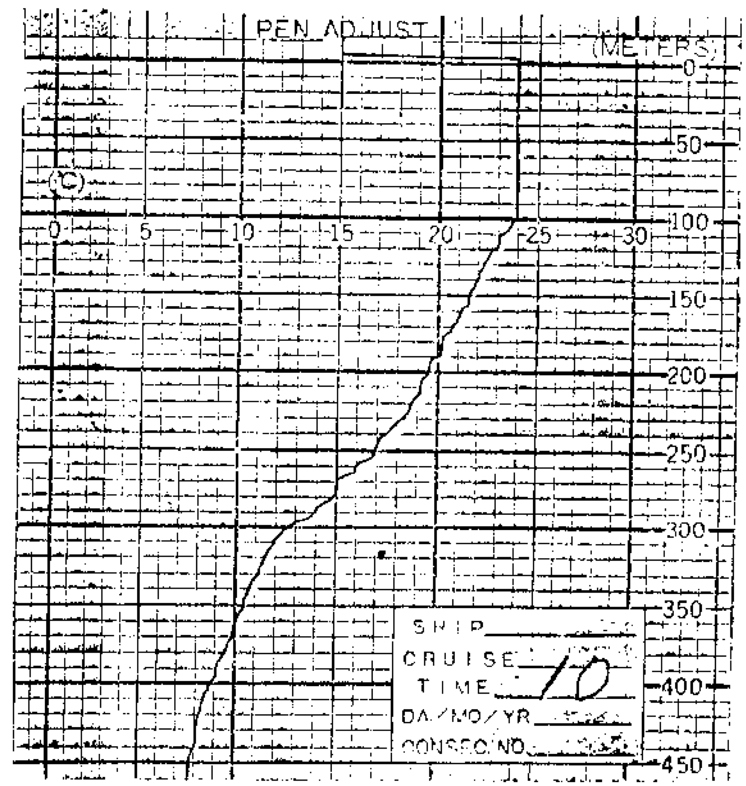


19°53.6'N
154°49.4'W

Feb. 6, 1983
0442 hr

Surface Temperature 23.6°C

Station 10

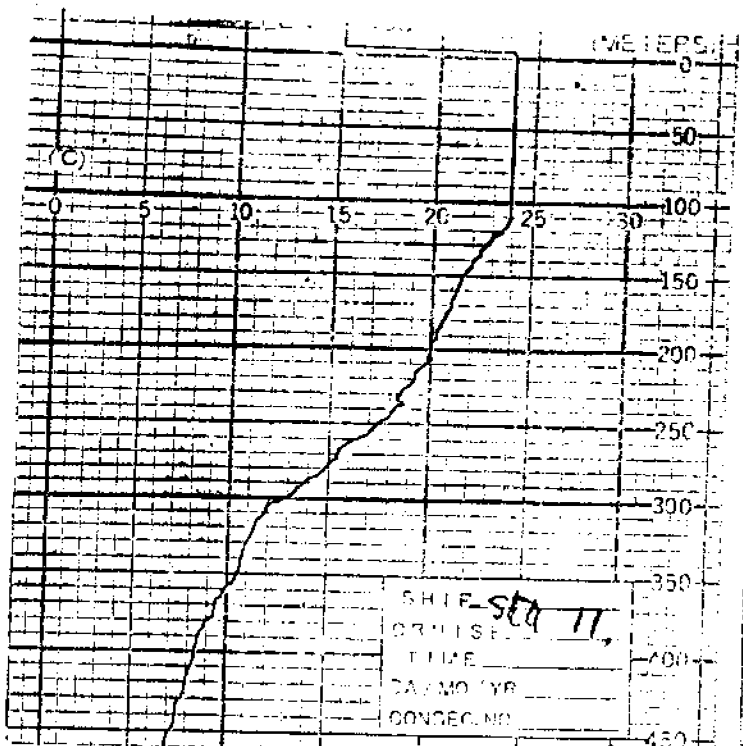


20°02.3'N
154°54.4'W

Feb. 6, 1983
0542 hr

Surface Temperature 23.6°C

Station 11

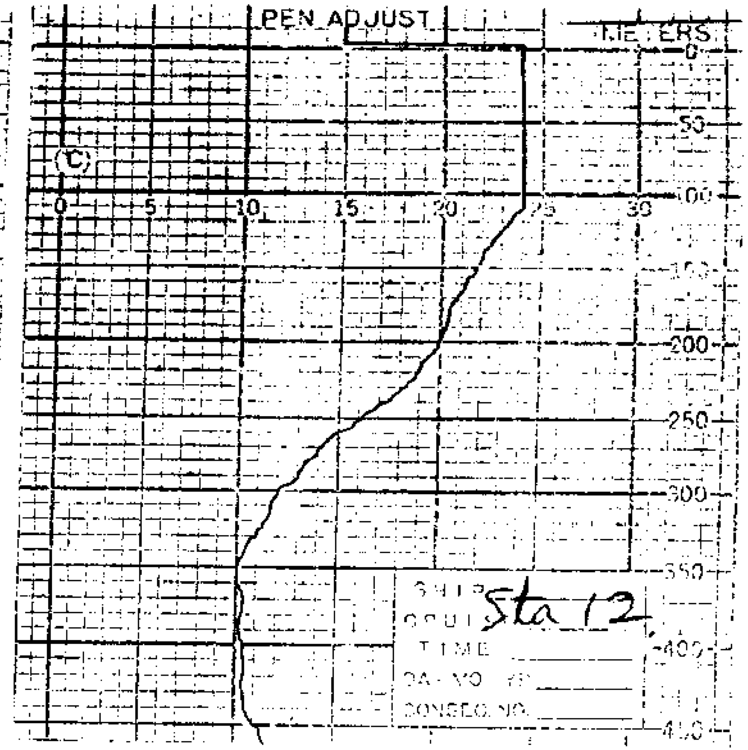


19°59.3'N
155°00.0'W

Feb. 6, 1983
0618 hr

Surface Temperature 23.6°C

Station 12

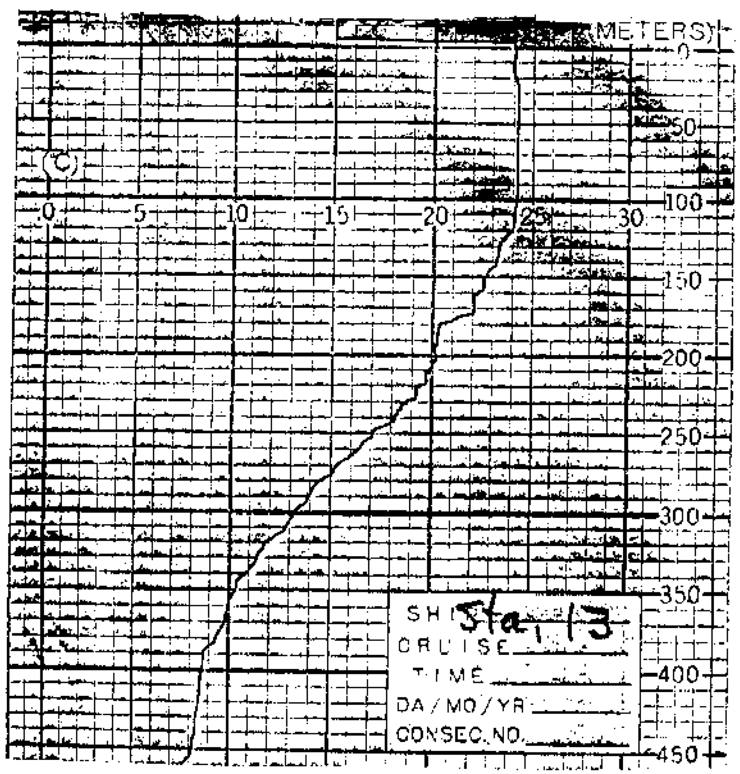


19°50.8'N
154°54.8'W

Feb. 6, 1983
0736 hr

Surface Temperature –

Station 13

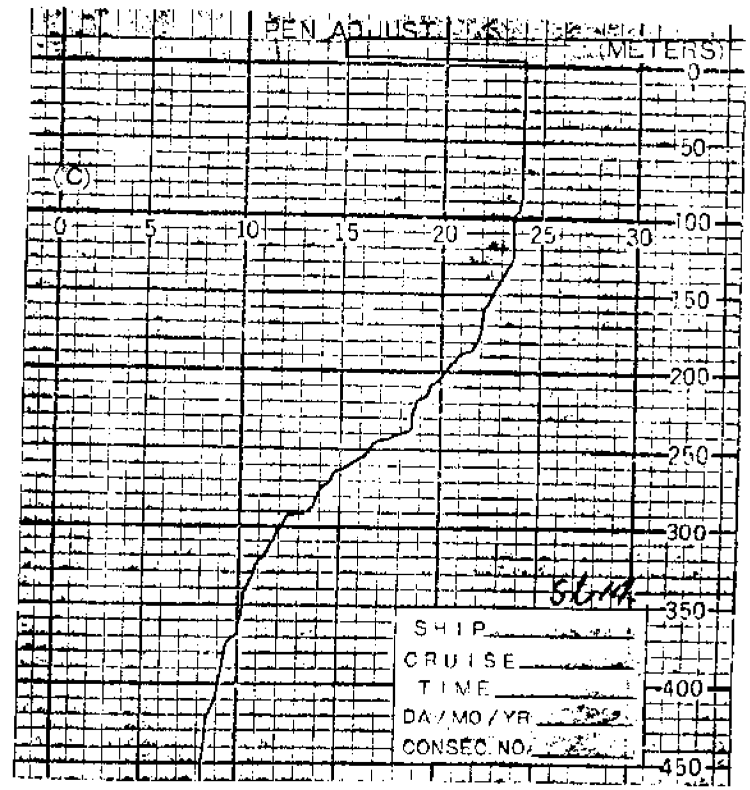


19°42.0'N
154°50.0'W

Feb. 6, 1983
0816 hr

Surface Temperature 23.6°C

Station 14

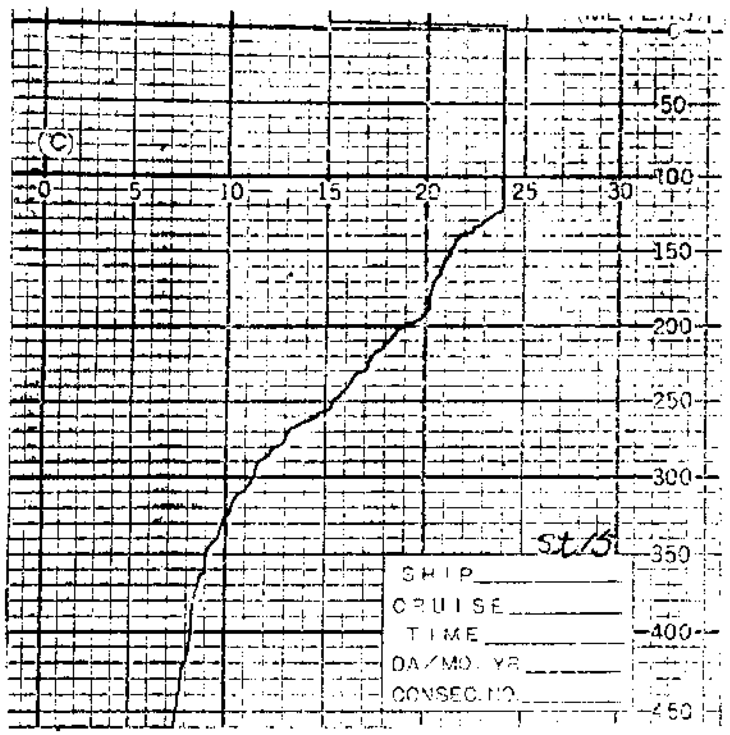


19°32.2'N
154°45.0'W

Feb. 6, 1983
0916 hr

Surface Temperature 23.8°C

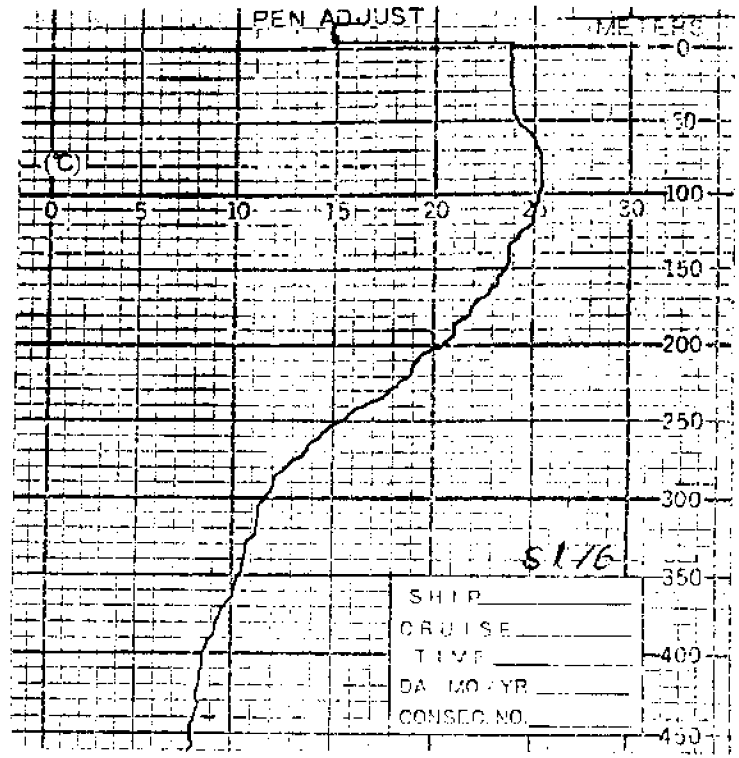
Station 15



19°24.4'N Feb. 6, 1983
154°40.5'W 1006 hr

Surface Temperature 24.0°C

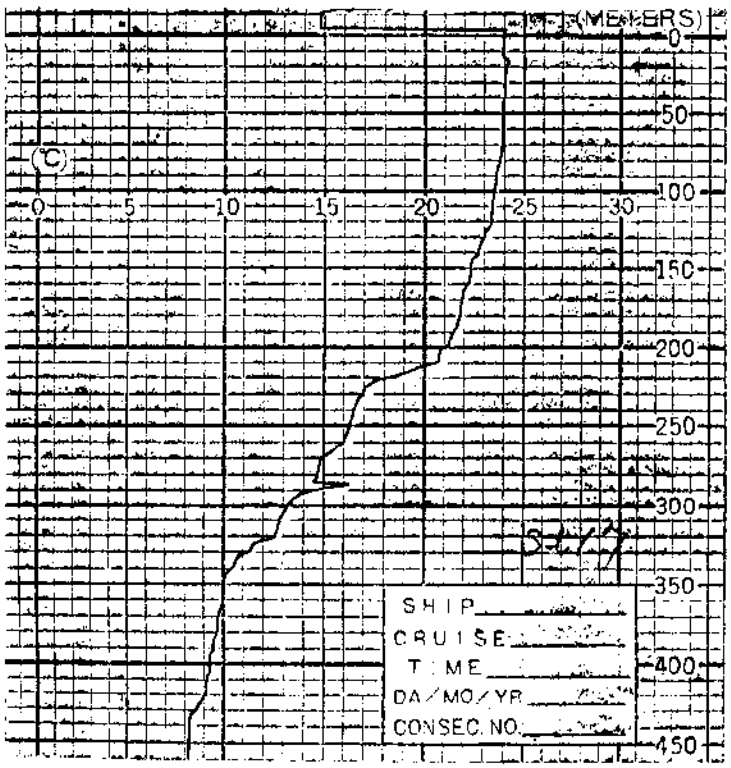
Station 16



19°27.0'N Feb. 6, 1983
154°45.5'W 1048 hr

Surface Temperature 23.9°C

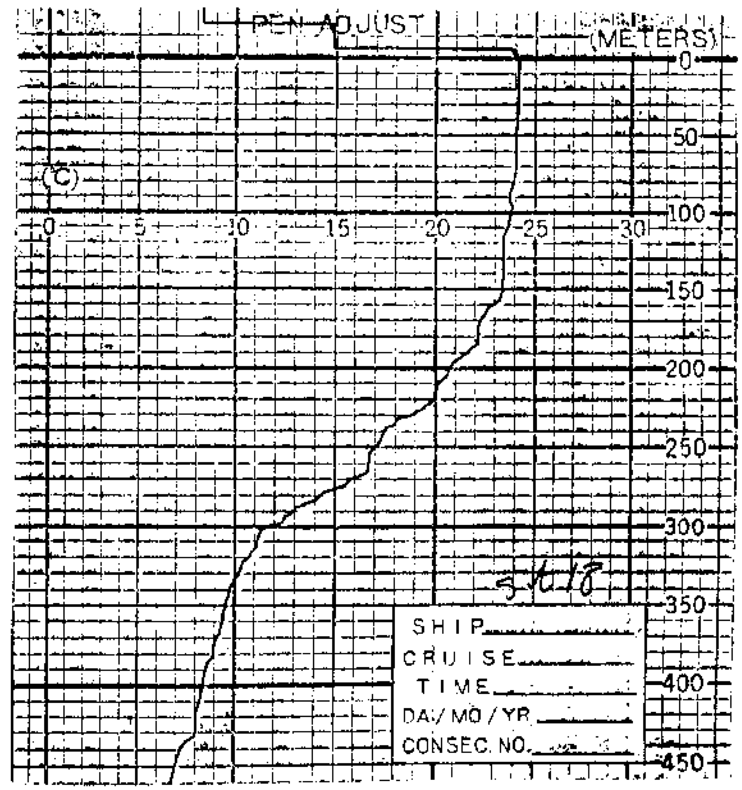
Station 17



19°32.5'N Feb. 6, 1983
154°48.3'W 1118 hr

Surface Temperature 24.0°C

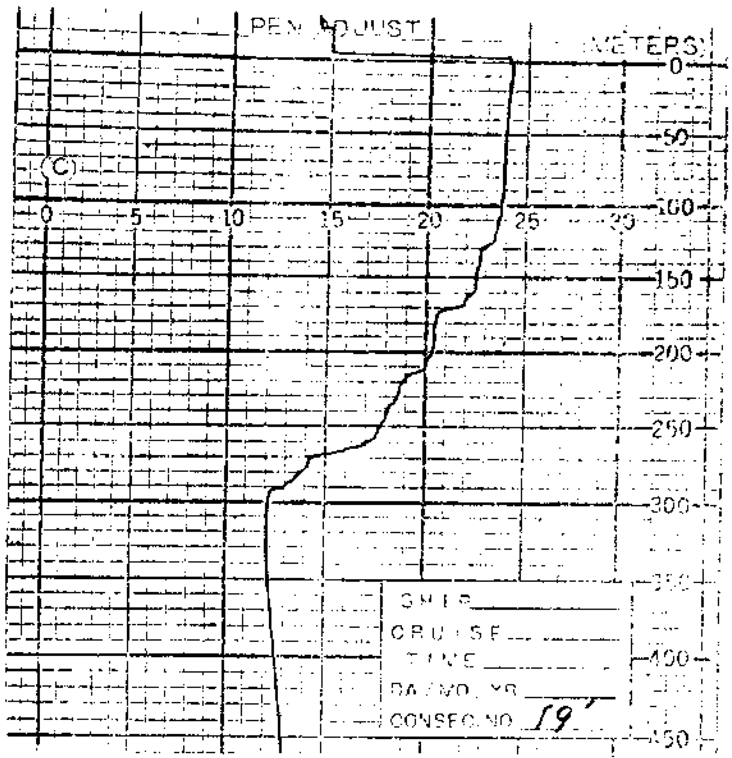
Station 18



19°35.7'N Feb. 6, 1983
154°54.4'W 1200 hr

Surface Temperature 24.0°C

Station 19

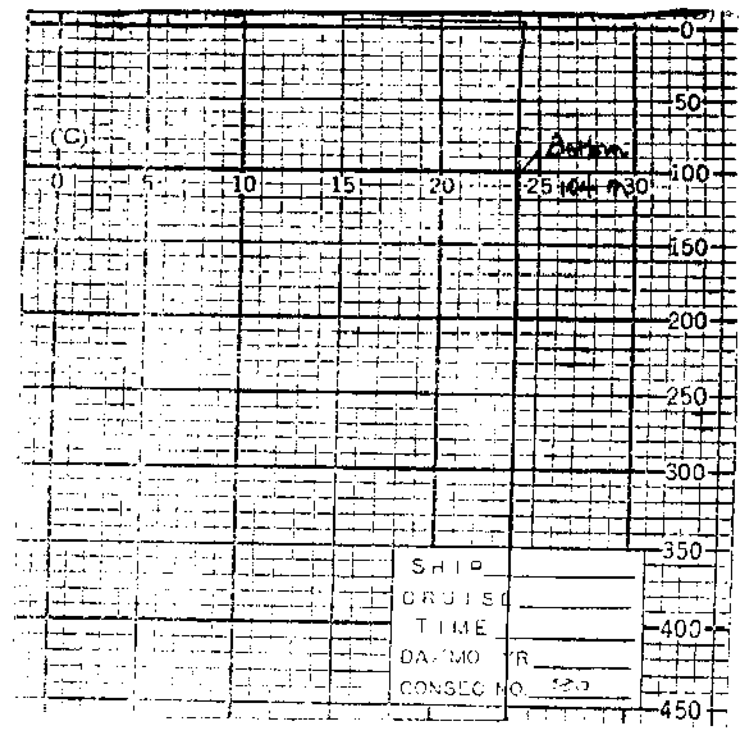


19°39.8′N
154°57.2′W

Feb. 6, 1983
1224 hr

Surface Temperature 24.1°C

Station 20

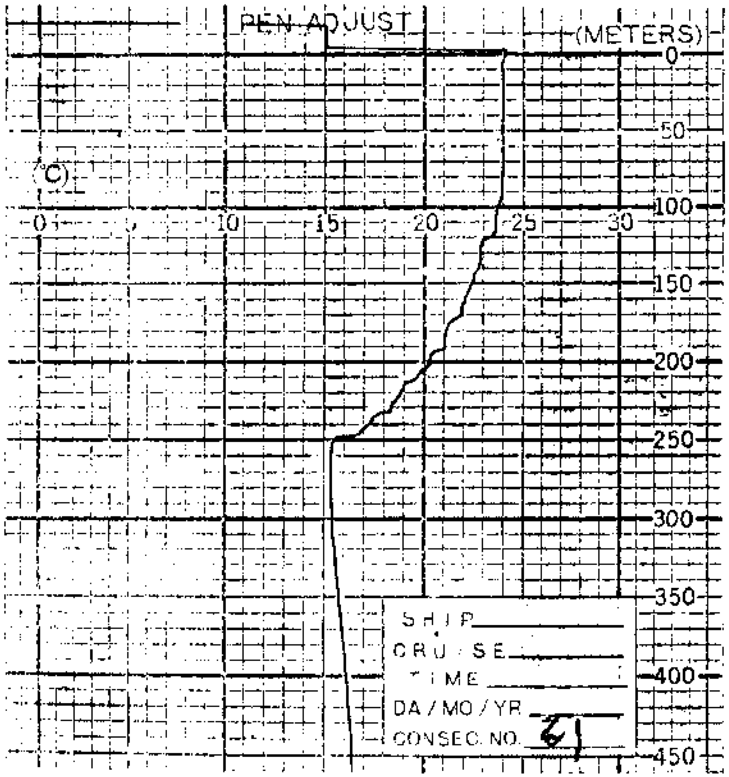


19°44.7′N
154°59.5′W

Feb. 6, 1983
1236 hr

Surface Temperature 24.2°C

Station 21

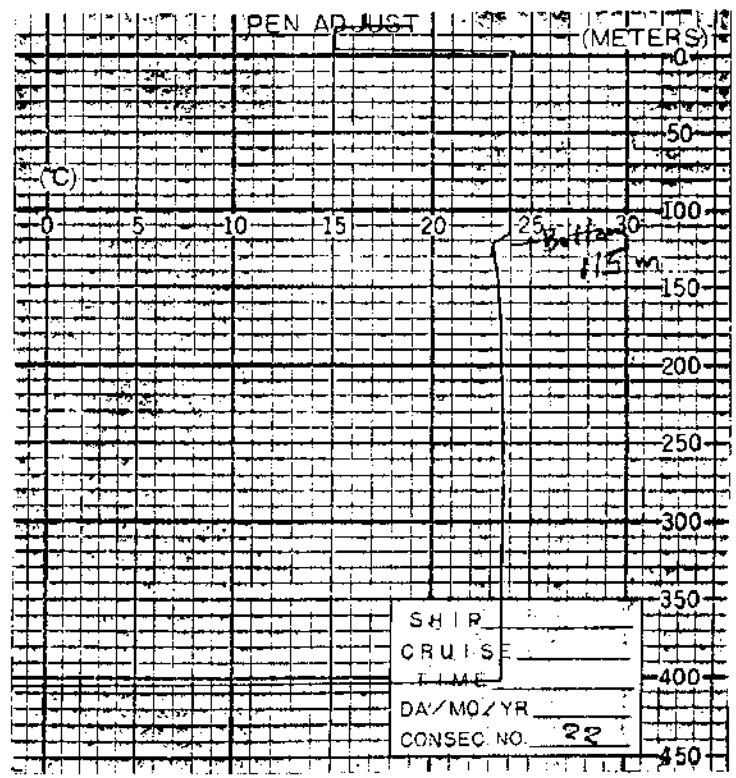


19°48.6'N 155°01.9'W

Feb. 6, 1983 1318 hr

Surface Temperature 24.0°C

Station 22

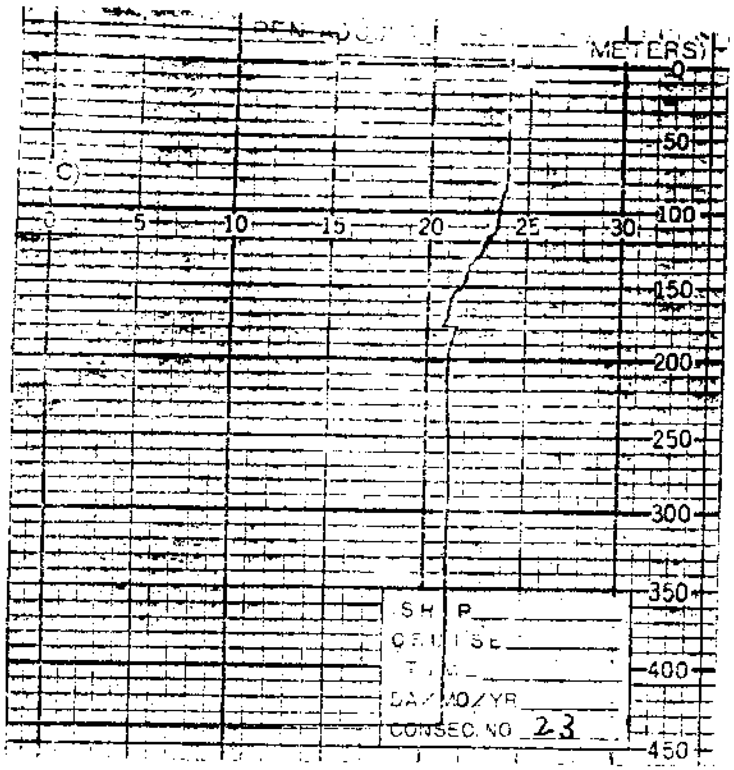


19°52.2'N 155°04.5'W

Feb. 6, 1983 1336 hr

Surface Temperature 24.2°C

Station 23

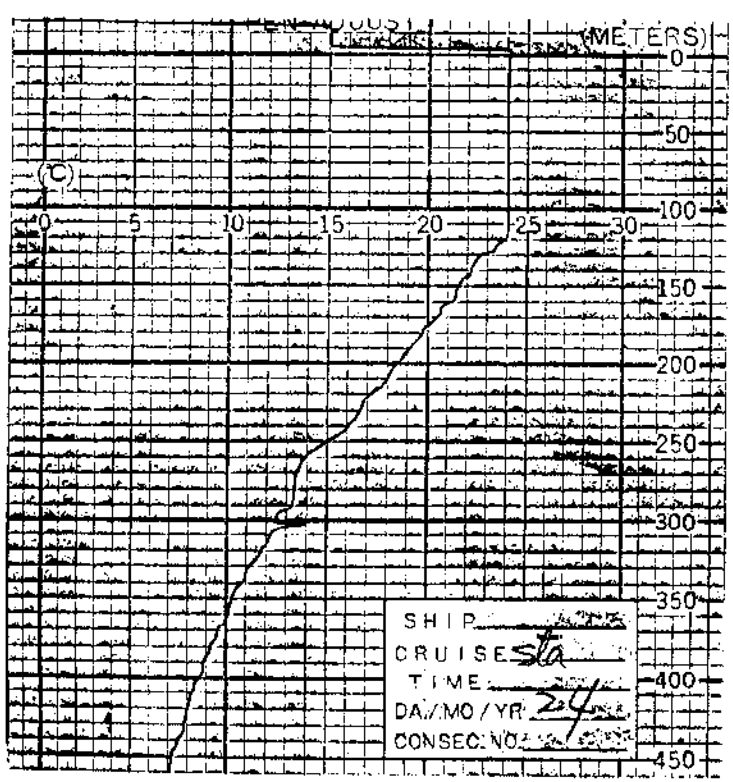


19°54.8'N
155°05.9'W

Feb. 6, 1983
1400 hr

Surface Temperature 24.0°C

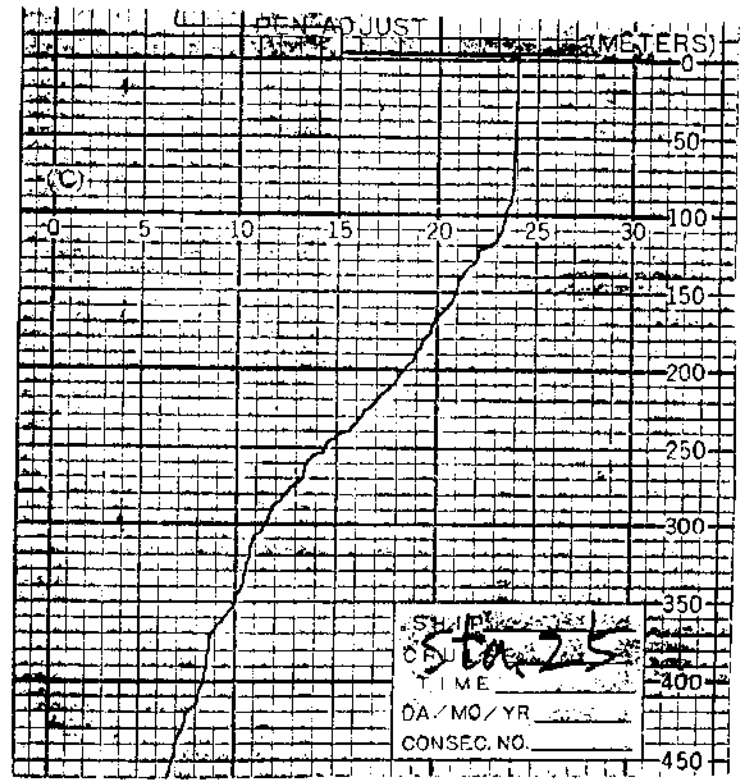
Station 24



20°07.2'N Feb. 6, 1983
154°45.2'W 1630 hr

Surface Temperature 23.9°C

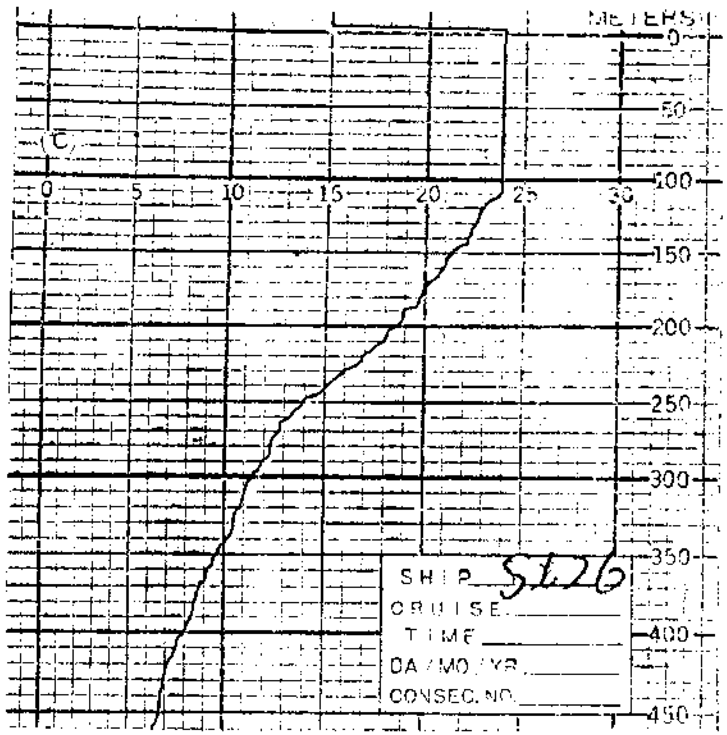
Station 25



20°00.7'N Feb. 6, 1983
154°49.7'W 1930 hr

Surface Temperature 23.8°C

Station 26

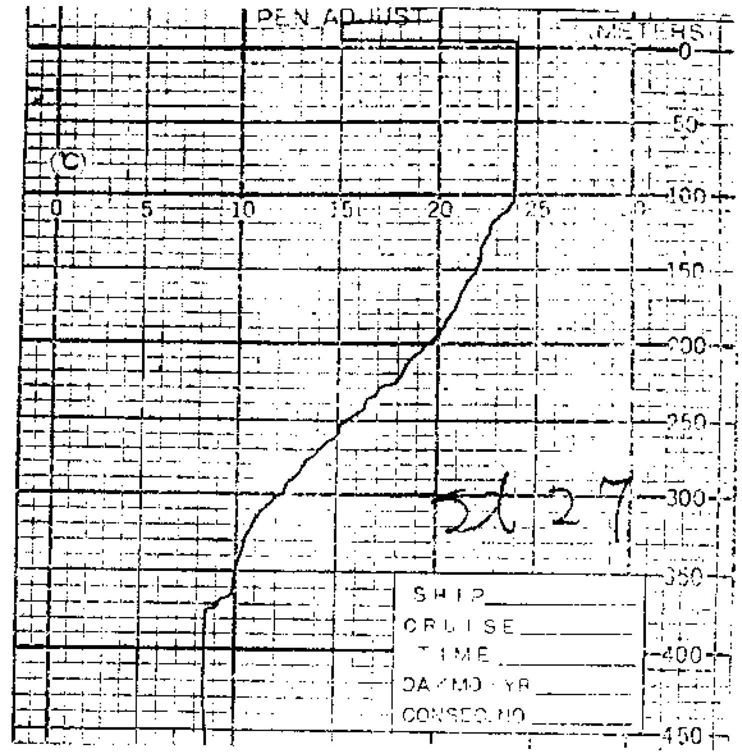


19°57.8'N
154°53.8'W

Feb. 6, 1983
2254 hr

Surface Temperature 23.5°C

Station 27

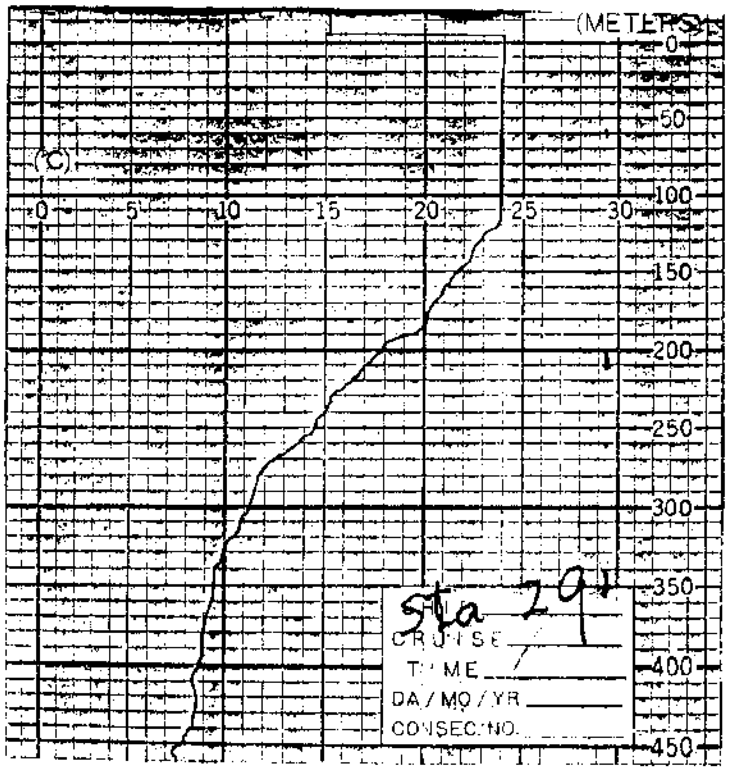


19°55.1'N
154°57.5'W

Feb. 7, 1983
0136 hr

Surface Temperature 23.5°C

Station 29

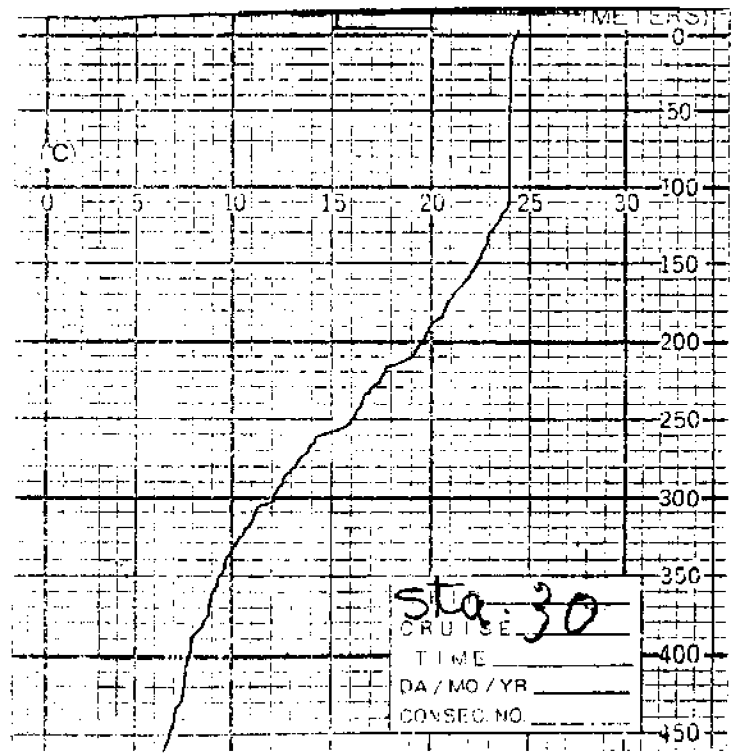


19°53.6'N 154°49.3'W

Feb. 9, 1983 2100 hr

Surface Temperature 23.8°C

Station 30

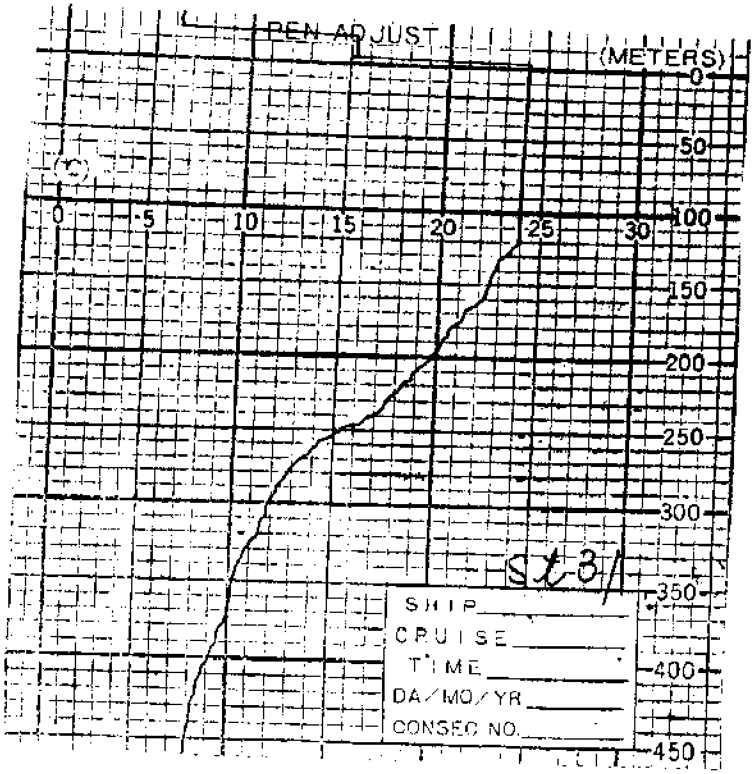


19°50.7'N 154°54.5'W

Feb. 7, 1983 1930 hr

Surface Temperature 24.1°C

Station 31

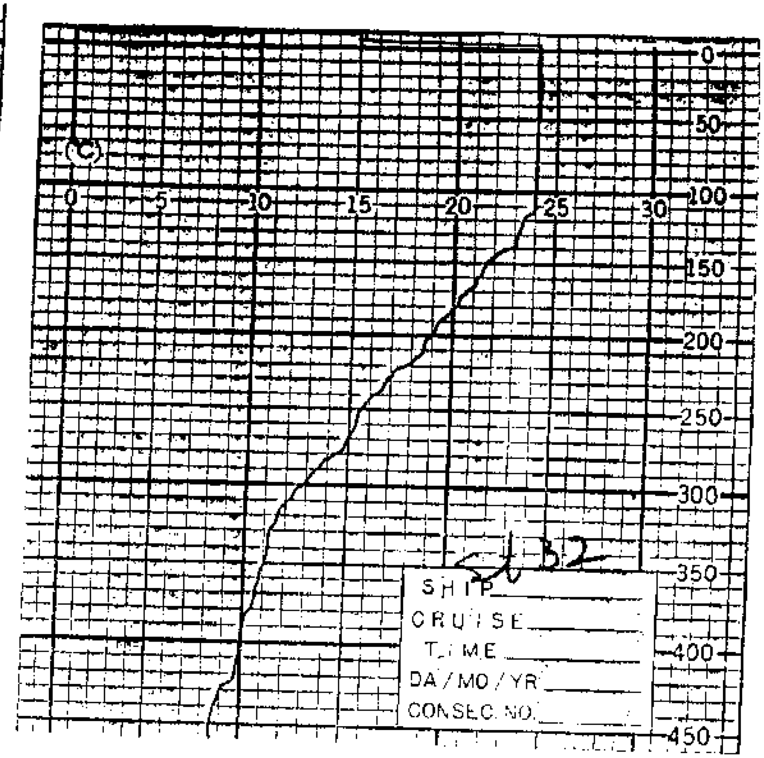


19°49.2'N
154°52.2'W

Feb. 7, 1983
2300 hr

Surface Temperature 23.8°C

Station 32

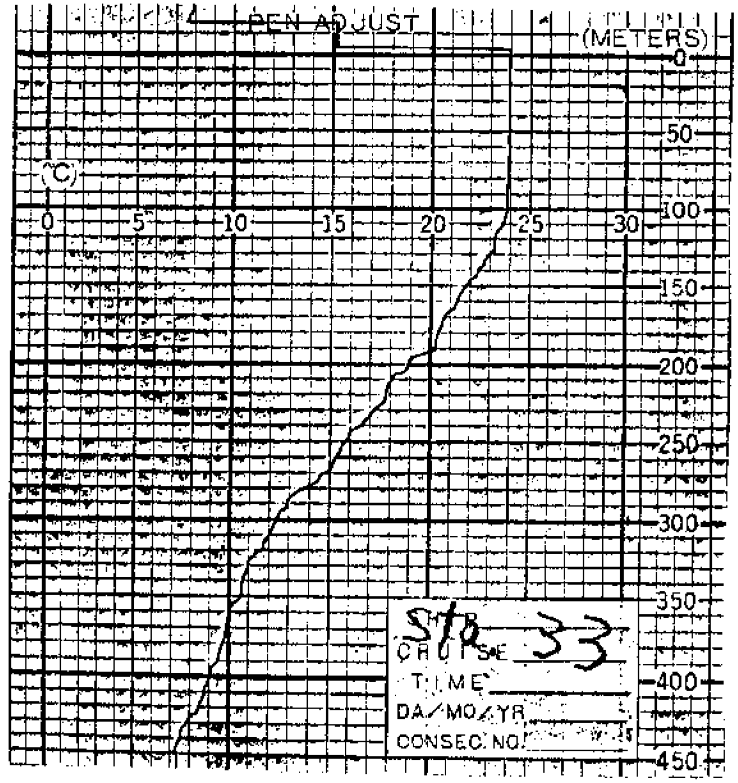


19°46.1'N
154°47.0'W

Feb. 8, 1983
0247 hr

Surface Temperature 23.6°C

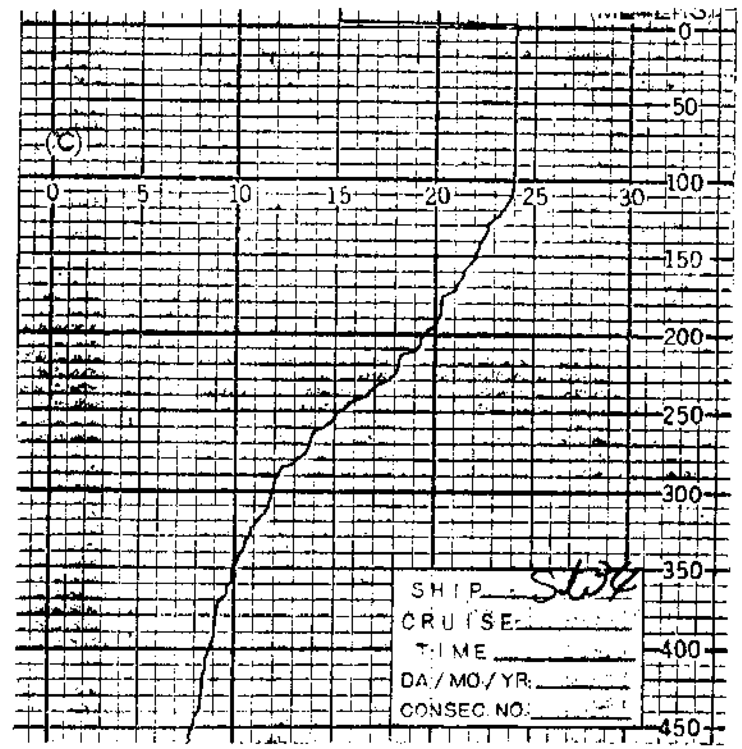
Station 33



19°58.7'N 154°39.8'W
Feb. 8, 1983 0712 hr

Surface Temperature 23.5°C

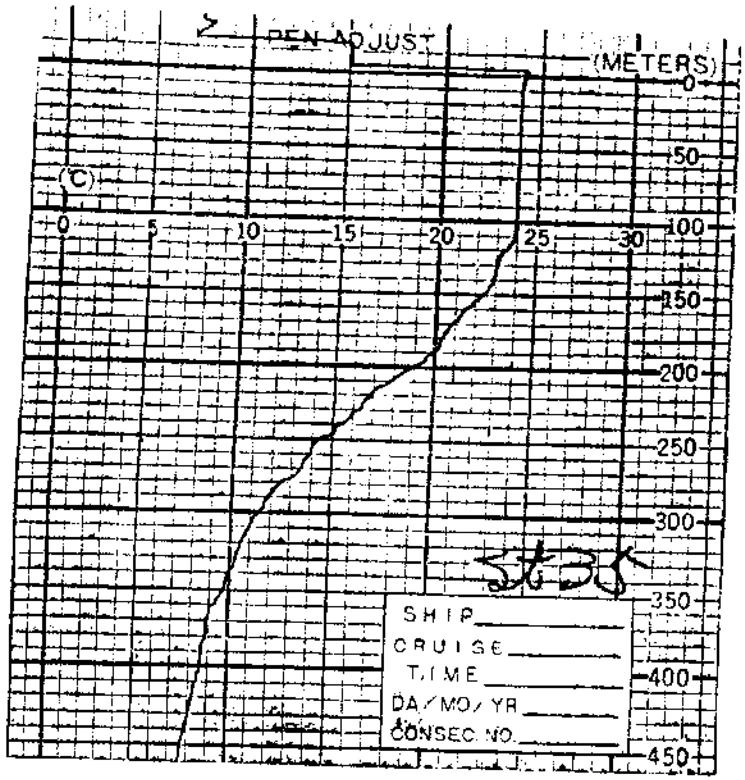
Station 34



19°49.3'N 154°35.1'W
Feb. 8, 1983 1012 hr

Surface Temperature 24.0°C

Station 35

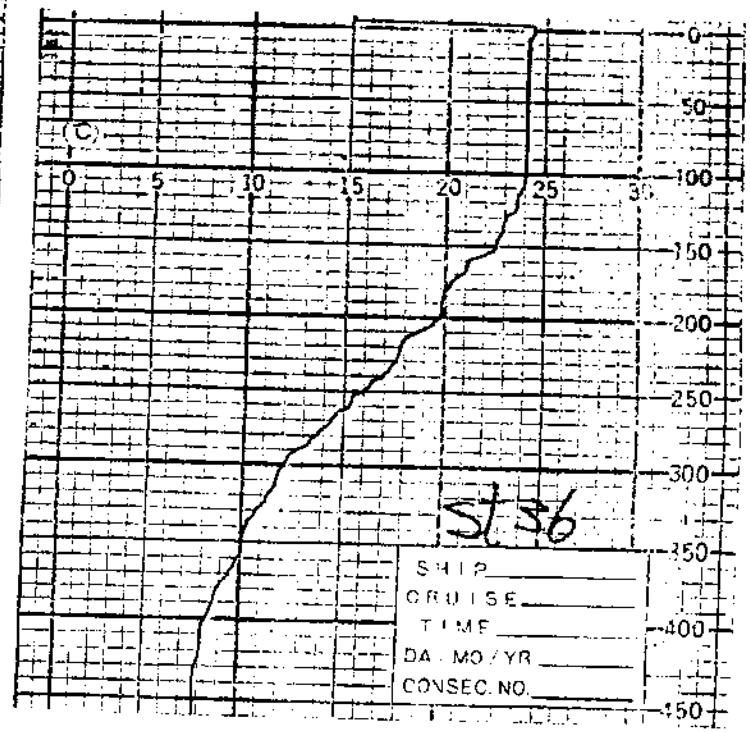


19°39.8'N 154°30.3'W

Feb. 8, 1983 1306 hr

Surface Temperature 23.8°C

Station 36

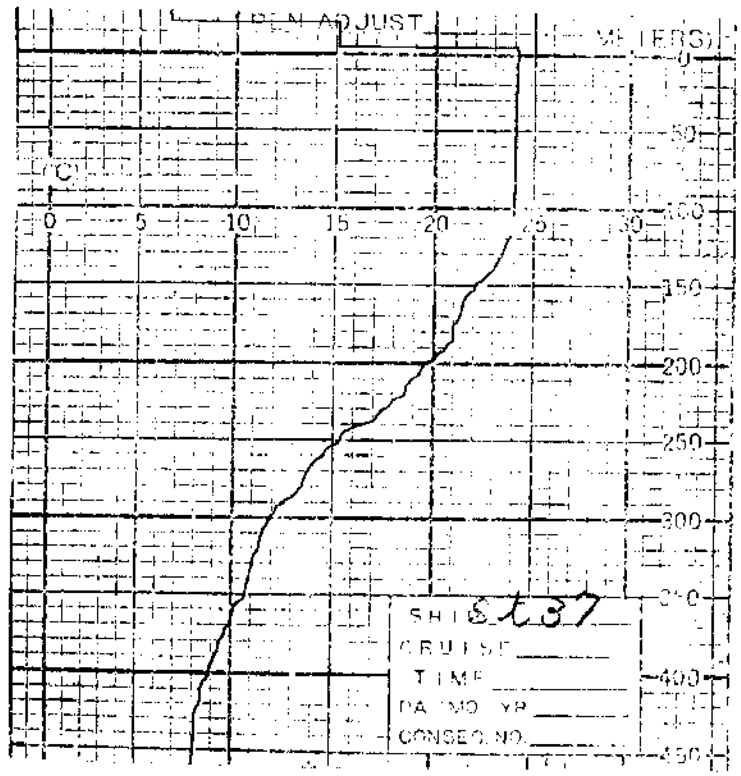


19°40.0'N 154°42.4'W

Feb. 8, 1983 1718 hr

Surface Temperature 24.4°C

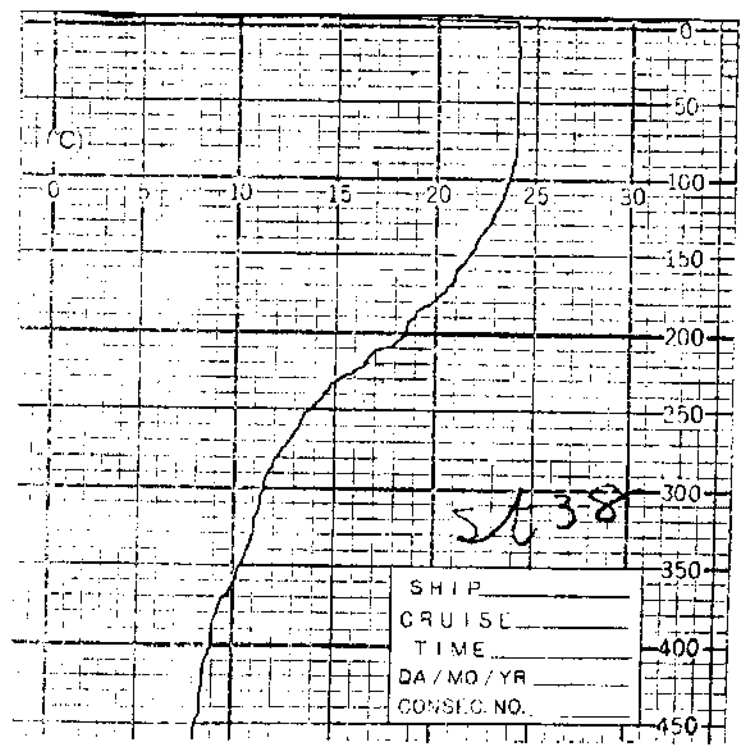
Station 37



19°37.2'N 154°43.5'W Feb. 8, 1983 2312 hr

Surface Temperature 23.8°C

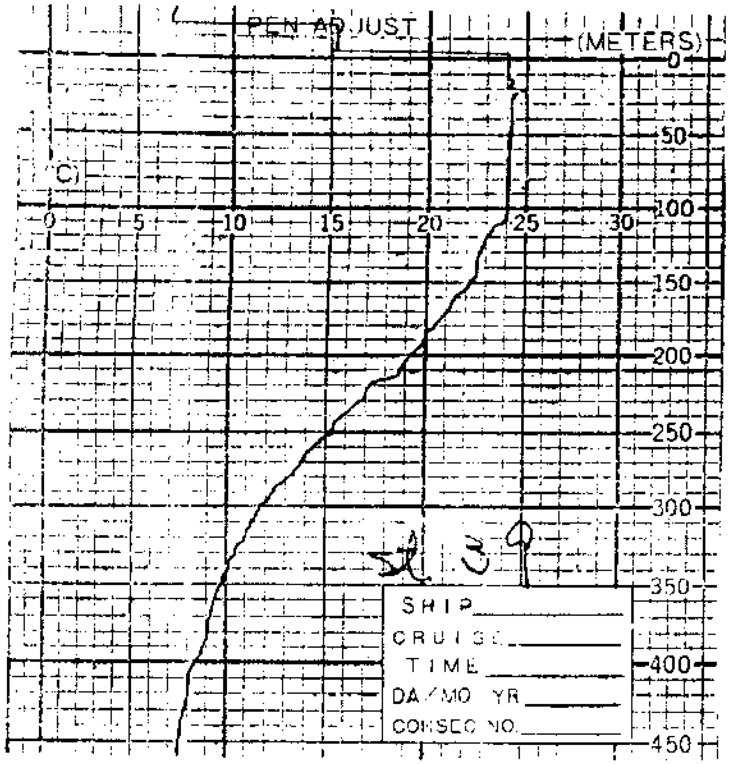
Station 38



19°33.2'N 154°45.2'W Feb. 9, 1983 0248 hr

Surface Temperature 23.6°C

Station 39

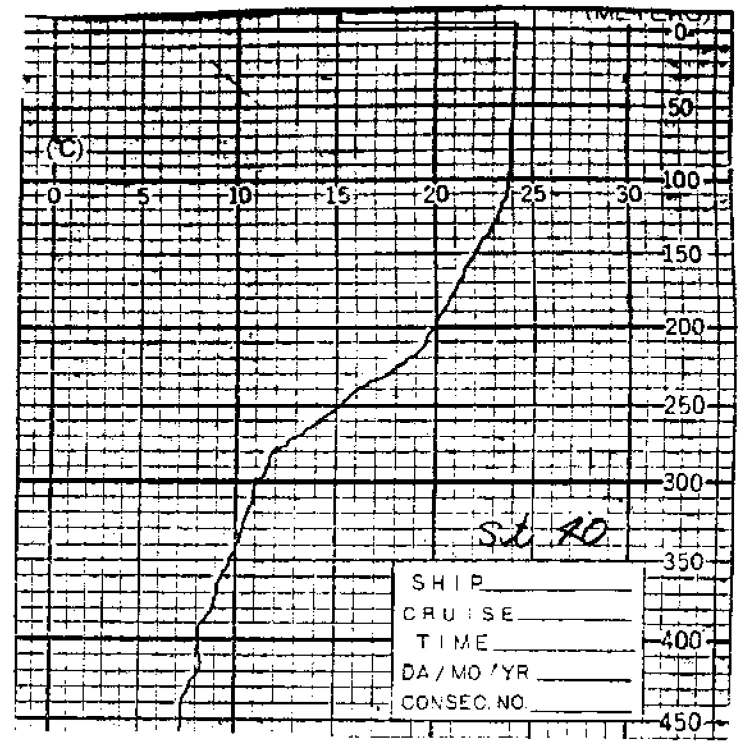


19°26.8'N
154°34.9'W

Feb. 9, 1983
0730 hr

Surface Temperature 23.4°C

Station 40

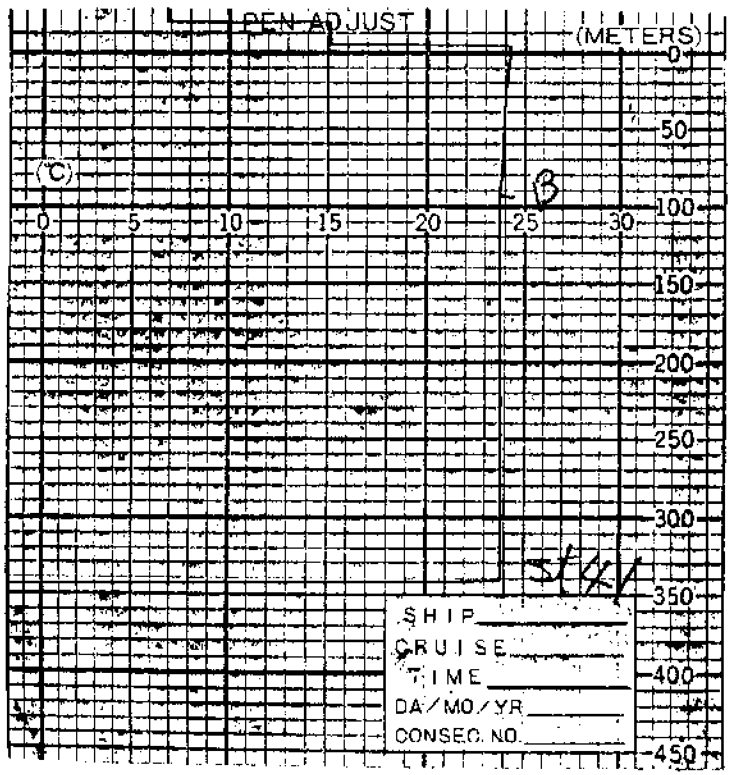


19°31.2'N
154°25.3'W

Feb. 9, 1983
1024 hr

Surface Temperature 23.8°C

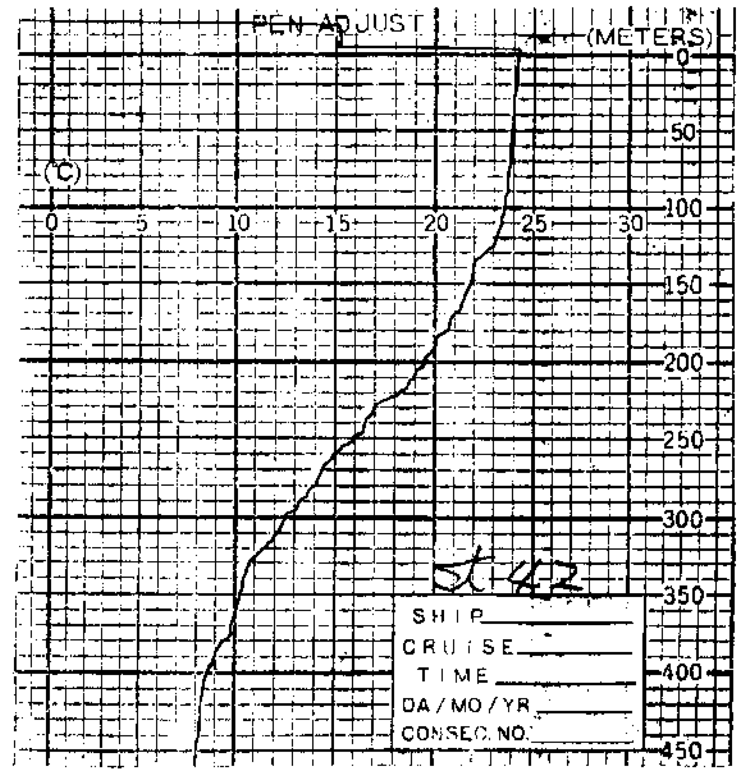
Station 41



19°38.6'N 154°57.4'W
Feb. 9, 1983 1442 hr

Surface Temperature 24.2°C

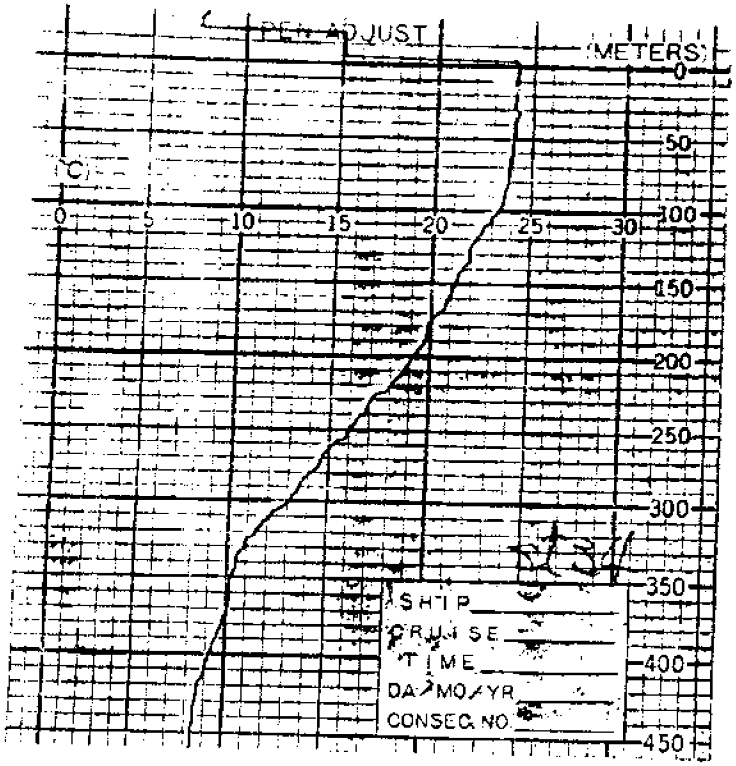
Station 42



19°39.5'N 154°56.8'W
Feb. 9, 1983 1636 hr

Surface Temperature 24.3°C

Station 43



19°38.8'N
154°49.3'W

Feb. 9, 1983
2100 hr

Surface Temperature 23.8°C

Appendix C. Hydrographic Data

Station 24 (H083045) Date: February 7, 1983 Position: 20°07.2'N, 154°45.2'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	23.90	34.93	23.64	0.034	3.205	0.0126	0.0114
10	23.88	34.89	23.61	0.074	4.897	0.0257	0.0015
25	23.87	34.85	23.59	0.005	3.012	0.0167	0.0031
50	23.86	34.88	23.61	0.040	4.108	0.0608	0.0027
75	23.88	34.90	23.62	Ud	4.273	0.0817	0.0044
100	23.87	34.90	23.63	0.015	6.817	0.0527	0.0033
125	23.85	34.92	23.65	0.052	3.797	0.0720	0.0177
150	22.47	35.06	24.15	0.110	5.916	0.0249	0.0156
175	20.76	35.14	24.68	0.530	3.975	0.0619	0.0503
200	19.13	35.02	25.03	0.356	1.933	0.0155	0.0145
250	16.03	34.62	25.47	2.624	3.969	0.0013	0.0063
0 to 200 m*				24.3	884	9.76	2.67
100 to 1 percent†				2.35	398	4.82	0.299
95 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 25 (H083046) Date: February 7, 1983 Position: 20°00.7'N, 154°43.7'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	23.80	34.94	23.68	0.038	2.437	0.0485	0.0287
10	23.82	34.92	23.65	Ud	2.999	0.0600	0.0200
25	23.86	34.88	23.61	Ud	1.017	0.0570	0.0221
50	23.89	34.88	23.60	Ud	3.000	0.0632	0.0127
75	23.81	34.88	23.63	Ud	3.740	0.0484	0.0254
100	23.58	34.93	23.73	Ud	3.172	0.0683	0.0161
125	22.66	35.02	24.07	0.190	4.502	0.1016	0.0658
150	21.50	35.09	24.45	Ud	2.219	0.0705	0.0391
175	20.20	35.09	24.80	0.758	1.686	0.0253	0.0222
200	18.60	34.95	25.10	1.714	3.523	0.0089	0.0123
250	14.76	34.48	25.64	3.546	5.296	0.0014	0.0063
0 to 200 m*				45.3	572	11.7	5.53
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 26 (H083047) Date: February 7, 1983 Position: 19°57.8'N, 154°53.8'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m⁻³)	Phaeopigments (mg · m⁻³)
0	23.50	34.90	23.73	–	–	(0.0372)	(0.0099)
10	23.61	34.90	23.70	0.015	1.964	0.0372	0.0099
25	23.77	34.91	23.66	Ud	2.162	0.0379	0.0067
50	23.76	34.91	23.66	Ud	1.742	0.0384	0.0178
75	23.74	34.90	23.67	Ud	2.310	0.0399	0.0153
100	23.61	34.96	23.75	Ud	2.319	0.0547	0.0340
125	22.96	35.09	24.03	0.012	2.649	0.1465	0.0705
150	21.93	35.17	24.38	–	2.067	0.0881	0.0829
175	20.59	35.13	24.73	0.932	3.608	0.0221	0.0254
200	19.10	35.00	25.01	–	3.245	0.0107	0.0113
250	15.22	34.52	25.58	–	3.949	0.0020	0.0080
0 to 200 m*				23.9	466	11.3	6.60
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 27 (H083048) Date: February 7, 1983 Position: 19°55.1'N, 154°57.5'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m⁻³)	Phaeopigments (mg · m⁻³)
0	23.50	34.96	23.78	–	–	(0.0243)	(0.0061)
10	23.60	34.94	23.74	Ud	2.225	0.0243	0.0061
25	23.75	34.91	23.67	Ud	2.798	0.0303	0.0106
50	23.74	34.91	23.67	0.006	2.451	0.0217	0.0060
75	23.73	34.90	23.67	Ud	2.478	0.0685	0.0172
100	23.62	34.95	23.73	Ud	2.911	0.0934	0.0197
125	22.73	35.10	24.11	0.472	2.453	0.0885	0.0667
150	21.90	35.22	24.43	Ud	2.356	0.0474	0.0446
175	21.04	35.21	24.66	Ud	3.695	0.0214	0.0181
200	20.12	35.09	24.82	0.077	2.845	0.0096	0.0171
250	17.04	34.65	25.26	2.256	4.566	0.0023	0.0085
0 to 200 m*				12.9	517	9.67	4.84
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 29 (H083064) Date: February 10, 1983 Position: 19°53.6'N, 154°49.3'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m^{-3})	Phaeopigments (mg · m^{-3})
0	23.80	34.86	23.62	Ud	2.913	0.0990	0.0208
10	23.75	34.88	23.65	Ud	3.151	0.0726	0.0047
25	23.68	34.92	23.70	Ud	2.977	0.0556	0.0061
50	23.69	34.91	23.69	Ud	2.010	0.0619	0.0101
75	23.69	34.89	23.67	Ud	1.824	0.0665	0.0158
100	23.67	34.92	23.70	Ud	2.275	0.1486	0.0058
125	23.07	35.06	23.98	Ud	2.420	0.1116	0.0590
150	22.18	35.19	24.33	0.576	1.713	0.0369	0.0413
175	20.93	35.19	24.68	1.274	3.539	0.0119	0.0158
200	19.46	35.05	24.96	2.119	3.214	0.0062	0.0074
250	14.61	34.45	25.65	7.100	7.936	0.0000	0.0070
0 to 200 m*				72.7	498	13.6	7.36
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 30 (H083050) Date: February 1983 Position: 19°50.7'N, 154°54.5'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m^{-3})	Phaeopigments (mg · m^{-3})
0	24.10	34.92	23.57	0.016	1.800	0.0660	0.0449
10	23.96	34.92	23.61	Ud	2.498	0.0524	0.0108
25	23.75	34.92	23.68	Ud	2.875	0.0529	0.0249
50	23.76	34.93	23.68	Ud	1.992	0.0500	0.0295
75	23.75	34.92	23.68	Ud	2.646	0.0778	0.0157
100	23.69	34.94	23.71	Ud	3.143	0.0654	0.0439
125	23.10	35.07	23.98	Ud	2.430	0.1271	0.0496
150	22.17	35.18	24.33	0.351	2.033	0.0534	0.0301
175	20.84	35.16	24.68	0.829	3.292	0.0372	0.0320
200	19.57	35.06	24.94	1.589	2.839	0.0125	0.0126
250	26.89	34.72	25.34	3.503	5.497	0.0023	0.0077
0 to 200 m*				49.4	523	12.5	6.04
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 31 (H083051) Date: February 8, 1983 Position: 19°49.2'N, 154°52.2'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m^{-3})	Phaeopigments (mg · m^{-3})
0	23.80	34.91	23.65	Ud	1.694	0.05124	0.0287
10	23.79	34.91	23.66	Ud	2.525	0.03807	0.0077
25	23.77	34.92	23.67	Ud	3.218	0.04326	0.0048
50	23.75	34.92	23.67	Ud	1.752	0.04795	0.0226
75	23.76	34.90	23.66	Ud	3.217	0.06538	0.0140
100	23.72	34.93	23.69	Ud	3.170	0.06078	0.0167
125	23.26	35.02	23.90	Ud	3.720	0.06243	0.0212
150	22.46	35.12	24.20	–	2.584	0.08575	0.0290
175	21.32	35.14	24.53	0.476	4.330	0.03939	0.0366
200	19.98	35.08	24.84	0.926	3.450	0.01197	0.0204
250	16.37	34.67	25.43	2.778	5.007	0.00120	0.0087
0 to 200 m*				29.4	617	10.8	4.09
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 32 (H083062) Date: February 1983 Position: 19°46.1'N, 154°47.0'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m^{-3})	Phaeopigments (mg · m^{-3})
0	23.60	34.85	23.67	Ud	3.452	0.0509	0.0533
10	23.75	34.87	23.64	Ud	2.935	0.0564	0.0190
25	23.97	34.89	23.59	Ud	2.704	0.0408	0.0103
50	23.91	34.88	23.60	Ud	2.418	0.0587	0.0347
75	23.89	34.87	23.60	Ud	3.319	0.0560	0.0234
100	23.85	34.91	23.64	Ud	2.848	0.0747	0.0411
125	23.12	35.05	23.95	Ud	3.367	0.0961	0.0375
150	22.00	35.15	24.35	0.524	1.594	0.1043	0.01147
175	20.45	35.12	24.75	0.901	4.043	0.0208	0.0257
200	18.89	34.99	25.06	2.364	3.806	0.0080	0.0134
250	15.69	34.56	25.50	4.714	7.096	0.0015	0.0087
0 to 200 m*				65.2	595	12.1	5.22
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 33 (H083053) Date: February 8, 1983 Position: 19°58.7'N, 154°39.8'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (µM)	Si (µM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	23.50	34.83	23.68	0.020	3.537	0.0757	0.0318
10	23.64	34.82	23.64	Ud	3.854	0.0557	0.0055
25	23.84	34.82	23.58	Ud	5.293	0.0632	0.0101
50	23.83	34.87	23.61	Ud	4.100	0.0763	0.0237
75	23.88	34.89	23.62	Ud.	3.580	0.0997	0.0178
100	23.78	34.94	23.68	Ud	3.769	0.0762	0.0186
125	23.34	35.02	23.87	Ud	4.564	0.1076	0.0336
150	22.24	35.09	24.24	Ud	2.731	0.0612	0.0667
175	20.72	35.09	24.66	0.558	5.215	0.0200	0.0243
200	19.08	34.98	25.01	1.773	3.887	0.0070	0.0090
250	15.82	34.60	25.50	3.899	5.379	0.0015	0.0059
0 to 200 m*				36.2	819	13.5	5.16
100 to 1 percent†				0.100	332	5.77	1.31
79 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 34 (H0083054) Date: February 1983 Position: 19°49.3'N, 154°35.1'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (µM)	Si (µM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	24.00	34.94	23.62	Ud	2.055	0.0448	0.0456
10	23.94	34.93	23.63	Ud	2.953	0.0560	0.0159
25	23.86	34.91	23.64	Ud	3.074	0.0600	0.0343
50	23.91	34.91	23.62	Ud	2.451	0.0712	0.0277
75	23.90	34.90	23.62	Ud	3.234	0.0626	0.0378
100	23.75	34.94	23.69	Ud	3.686	0.0717	0.0395
125	23.04	35.04	23.97	Ud	2.180	0.1697	0.0142
150	22.00	35.11	24.32	0.311	3.146	0.0987	0.1217
175	20.78	35.12	24.67	0.823	2.625	0.0344	0.0531
200	19.52	35.07	24.96	1.819	2.545	0.0144	0.0141
250	16.39	34.68	25.43	3.745	4.928	0.0016	0.0086
0 to 200 m*				51.1	574	15.0	8.64
100 to 1 percent†				Ud	277	5.26	3.24
84 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 35 (H083055) Date: February 8, 1983 Position: 19°39.8'N, 154°30.3'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* ($mg \cdot m^{-3}$)	Phaeopigments ($mg \cdot m^{-3}$)
0	23.80	34.93	23.67	Ud	1.557	0.0466	0.0195
10	23.83	34.92	23.65	Ud	1.716	0.0526	0.0128
25	23.87	34.91	23.63	Ud	2.548	0.0442	0.0157
50	23.83	34.91	23.64	Ud	2.679	0.0584	0.0126
75	23.86	34.90	23.62	Ud	2.047	0.0627	0.0223
100	23.83	34.94	23.67	Ud	2.280	0.0597	0.0239
125	23.37	35.08	23.91	0.020	2.830	0.0956	0.0757
150	22.54	35.19	24.23	0.043	1.752	0.0637	0.0658
175	21.29	35.19	24.58	0.893	3.898	0.0096	0.0169
200	19.54	35.06	24.95	2.005	2.969	0.0058	0.0124
250	15.64	34.60	25.54	4.786	6.126	0.0003	0.0112
0 to 200 m*				49.0	504	10.6	6.18
100 to 1 percent†				Ud	480	9.77	5.55
116 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 36 (H083056) Date: February 9, 1983 Position: 19°40.0'N, 154°42.4'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* ($mg \cdot m^{-3}$)	Phaeopigments ($mg \cdot m^{-3}$)
0	24.40	34.88	23.45	Ud	2.466	0.0552	0.0180
10	24.19	34.88	23.51	Ud	2.782	0.0581	0.0104
25	23.88	34.88	23.61	Ud	2.909	0.0657	0.0054
50	23.89	34.91	23.63	Ud	2.767	0.0767	0.0065
75	23.86	34.91	23.63	Ud	1.694	0.0875	0.0128
100	23.76	34.93	23.68	Ud	2.466	0.0936	0.0126
125	23.20	35.00	23.90	Ud	2.458	0.1176	0.0132
150	22.03	35.05	24.27	0.149	2.062	0.0791	0.0695
175	20.57	35.05	24.67	0.392	2.952	0.0474	0.0589
200	19.21	34.97	24.96	2.145	3.407	0.0162	0.0154
250	16.06	34.61	25.45	3.663	5.212	0.0027	0.0077
0 to 200 m*				40.3	508	15.1	4.86
100 to 1 percent†				Ud	248	7.59	0.968
100 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 37 (H083057) Date: February 9, 1983 Position: 19°37.2'N, 154°43.5'W.

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg m⁻³)	Phaeopigments (mg m⁻³)
0	23.80	34.88	23.63	Ud	2.648	0.0365	0.0482
10	23.84	34.87	23.61	Ud	3.021	0.0332	0.0096
25	23.89	34.86	23.59	Ud	3.516	0.0379	0.0066
50	23.89	34.88	23.60	Ud	3.655	0.0538	0.0097
75	23.89	34.87	23.60	Ud	3.057	0.0899	0.0318
100	23.82	34.89	23.63	Ud	3.211	0.1024	0.0573
125	23.22	34.96	23.86	0.152	3.115	0.0956	0.0501
150	22.41	35.04	24.15	0.214	2.285	0.0815	0.0563
175	21.50	35.07	24.43	0.726	3.972	0.0262	0.0304
200	20.33	35.03	24.72	1.592	3.064	0.0116	0.0074
250	16.80	34.68	25.34	3.264	5.085	0.0028	0.0168
0 to 200 m*				46.4	642	12.7	6.48
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 38 (H083058) Date: February 9, 1983 Position: 19°33.2'N, 154°45.2'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	23.60	34.72	23.57	Ud	5.163	0.0933	0.0405
10	23.74	34.75	23.55	Ud	6.919	0.0793	0.0401
25	23.96	34.80	23.52	Ud	3.861	0.0489	0.0093
50	23.90	34.85	23.58	Ud	3.573	0.0477	0.0141
75	23.80	34.86	23.61	0.058	2.970	0.0870	0.0265
100	23.63	34.90	23.69	0.038	3.098	0.1345	0.0221
125	22.95	35.02	23.98	0.017	1.938	0.1362	0.0360
150	22.06	35.11	24.31	0.304	3.512	0.0557	0.0692
175	20.87	35.10	24.62	0.755	2.334	0.0531	0.0329
200	19.38	34.98	24.92	1.483	2.833	0.0146	0.0164
250	15.25	34.52	25.57	–	6.764	0.0014	0.0069
0 to 200 m*				43.8	1439	15.4	6.12
100 to 1 percent†							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level

Station 39 (H083059)   Date: February 9, 1983   Position: 19°26.8'N, 154°34.9'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m⁻³)	Phaeopigments (mg · m⁻³)
0	23.40	34.95	23.80	0.002	1.838	0.0635	0.0223
10	23.52	34.93	23.75	Ud	1.400	0.0483	0.0130
25	23.71	34.91	23.68	Ud	2.178	0.0517	0.0038
50	23.74	34.89	23.66	Ud	1.992	0.0697	0.0112
75	23.75	34.89	23.65	Ud	2.329	0.0958	0.0287
100	23.49	34.96	23.78	Ud	1.848	0.0727	0.0221
125	22.83	35.09	24.07	Ud	2.320	0.1186	0.0114
150	21.86	35.17	24.40	0.231	2.027	0.1563	0.0233
175	20.67	35.16	24.72	0.315	3.477	0.0700	0.0392
200	19.42	35.07	24.99	1.398	2.678	0.0214	0.0172
250	15.82	34.64	25.53	—	4.176	0.0010	0.0047
0 to 200 m*				31.1	454	16.8	3.96
100 to 1 percent†				0.01	180	6.07	1.38
89 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 40 (H083060)   Date: February 9, 1983   Position: 19°31.2'N, 154°25.3'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg · m⁻³)	Phaeopigments (mg · m⁻³)
0	23.80	34.94	23.68	Ud	1.479	0.0229	0.0424
10	23.80	34.93	23.67	Ud	1.860	0.0491	0.0174
25	23.80	34.91	23.65	Ud	3.081	0.0426	0.0259
50	23.83	34.88	23.62	Ud	2.864	0.0286	0.0076
75	23.81	34.86	23.61	Ud	2.522	0.0667	0.0267
100	23.54	34.89	23.72	Ud	2.857	0.1321	0.0715
125	22.72	35.00	24.03	—	2.856	0.1928	0.0446
150	21.97	35.11	24.33	0.360	1.999	0.0480	0.0286
175	20.98	35.16	24.64	0.859	3.531	0.0172	0.0228
200	19.62	35.06	24.93	1.625	3.002	0.0039	0.0084
250	15.12	34.48	25.56	4.422	5.803	0.0011	0.0107
0 to 200 m*				55.3	546	13.8	6.10
100 to 1 percent†				Ud	248	4.99	2.36
95 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 41 (H083061) Date: February 10, 1983 Position: 19°38.6'N, 154°57.4'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si	Chlorophyll *a* (mg · m^{-3})	Phaeopigments
0	24.20	34.73	23.40	0.091	10.024	0.0697	0.0187
10	24.08	34.79	23.48	Ud	3.083	0.0719	0.0008
25	23.90	34.89	23.61	Ud	2.711	0.0596	0.0138
50	23.76	34.90	23.66	0.007	1.288	0.1225	0.0288
75				0.010	2.534	0.2194	0.0672
100				0.153	2.904	0.0445	0.0241
0 to 100 m*				2.79	274	11.5	3.08
100 to 1 percent†				0.688	205	8.04	1.94
68 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 42 (H083062) Date: February 10, 1983 Position: 19°39.5'N, 154°56.8'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si	Chlorophyll *a* (mg · m^{-3})	Phaeopigments
0	24.30	34.35	23.08	0.118	8.297	0.0892	0.0258
10	24.14	34.55	23.28	Ud	3.136	0.0557	0.0035
25	23.89	34.84	23.57	Ud	3.552	0.0376	0.0043
50	23.78	34.86	23.62	Ud	2.856	0.0612	0.0361
75	23.59	34.88	23.69	–	2.679	0.2366	0.0133
100	23.32	34.93	23.81	0.208	3.082	0.0811	0.0384
125	22.40	35.04	24.15	0.497	2.686	0.0365	0.0487
150	21.51	35.09	24.44	0.802	2.257	0.0330	0.0320
175	20.49	35.02	24.67	–	–	0.0146	0.0028
200	19.26	34.90	24.90	2.012	4.010	0.0064	0.0091
250	16.20	34.65	25.46	3.138	3.159	0.0001	0.0096
0 to 200 m*				101	619	13.5	4.66
100 to 1 percent†				0.590	243	5.29	1.27
70 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Station 43 (H083063)　　Date: February 10, 1983　　Position: 19°38.8'N, 154°55.8'W

Depth (m)	Temperature (°C)	Salinity (°/oo)	σt	NO_3+NO_2 (μM)	Si (μM)	Chlorophyll *a* (mg·m⁻³)	Phaeopigments (mg·m⁻³)
0	23.70	34.48	23.36	0.110	11.279	0.1008	0.0337
10	23.78	34.62	23.44	0.001	3.860	0.0548	0.0017
25	23.91	34.82	23.55	Ud	2.726	0.0575	0.0055
50	23.80	34.85	23.61	Ud	2.184	0.0582	0.0143
75	23.58	34.87	23.69	0.015	1.857	0.0737	0.0309
100	23.30	34.93	23.81	0.178	1.986	0.0614	0.0475
125	22.42	35.04	24.15	0.409	2.184	0.0614	0.0564
150	21.28	35.09	24.51	Ud	1.869	0.0316	0.0319
175	20.05	35.02	24.78	1.763	2.771	0.0103	0.0119
200	18.79	34.89	25.01	2.412	3.648	0.0044	0.0063
250	16.16	34.60	25.42	5.523	7.042	0.0005	0.0083
0 to 200 m*				89.8	526	9.81	5.20
100 to 1 percent†							
68 m§							

*Integrated from surface to 200 m depth
†Integrated from surface to 1 percent of surface light level
§Depth of 1 percent surface light level

Appendix D. Table of depth of deep chlorophyll maximum layer (CML), mixed layer, and 1 percent light level with integrated chlorophyll *a* and phaeopigments, February 7-10, 1983

DEPTH OF DEEP CHLOROPHYLL MAXIMUM LAYER (CML), MIXED LAYER, AND 1 PERCENT LIGHT LEVEL WITH INTEGRATED CHLOROPHYLL *a* AND PHAEOPIGMENTS, FEBRUARY 7-10, 1983

Station	CML		Surface Concen. (mg m^{-3})	CML:Surface	Standing Crop*		C / C + P	Depth of Mixed Layer (m)	Depth of 1% Light (m)
	Depth (m)	Concen. (mg m^{-3})			Chl. *a* (mg m^{-2})	Phaeo (mg m^{-2})			
24	75	0.0817	0.0126	6.484	9.76	2.67	0.785	120	95
25	125	0.1016	0.0485	2.095	11.7	5.53	0.679	90	—
26	125	0.1465	0.0372	3.938	11.3	6.60	0.631	110	—
27	100	0.0934	0.0243	3.844	9.67	4.84	0.666	105	—
—	—	—							
29	100	0.1486	0.0990	1.501	13.6	7.36	0.649	120	—
30	125	0.1271	0.0660	1.926	12.5	6.04	0.674	115	—
31	150	0.0858	0.0512	1.676	10.8	4.09	0.725	120	—
32	150	0.1043	0.0509	2.049	12.1	5.22	0.699	115	—
33	125	0.1076	0.0757	1.421	13.5	5.16	0.723	110	79
34	125	0.1697	0.0448	3.788	15.0	8.64	0.635	110	84
35	125	0.0956	0.0466	2.052	10.6	6.18	0.632	110	116
36	125	0.1176	0.0552	2.130	15.1	4.86	0.757	110	100
37	100	0.1024	0.0365	2.805	12.7	6.48	0.662	120	—
38	125	0.1362	0.0933	1.460	15.4	6.12	0.716	95	—
39	150	0.1563	0.0635	2.461	16.8	3.96	0.809	110	89
40	125	0.1928	0.0229	8.419	13.8	6.10	0.693	100	95
41	75	0.2194	0.0697	3.148	11.5†	3.08†	0.789	100	68
42	75	0.2366	0.0892	2.652	13.5	4.66	0.743	110	70
43	75	0.0737	0.1008	0.731	9.81	5.20	0.654	90	68
N = 19									
Mean	117	0.1346	0.0573	2.873	12.65§	5.54§	0.701	108	
Standard Deviation	24	0.0457	0.0259	1.862	2.11	1.35	0.056	10	

*Integrated from 0 m to 200 m
†Integrated from 0 m to 100 m
§N = 18

Appendix E. Table of catch data for *Nototodarus hawaiiensis*

CATCH DATA FOR *NOTOTODARUS HAWAIIENSIS*

Mantle Length (mm)	Sex	Maturity*
130	M	M
120	M	M
110	M	I
125	M	M
135	M	M
130	M	M
145	F	M
160	F	M
58	M	I
59	F	I
73	F	I
60	†	I
44	M	M
43	F	I
49	F	I

*M = mature
I = immature
† = sex unknown

Appendix F. Catch data for *Sthenoteuthis oualaniensis*

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
25	128	77	F	I	U
25	133	98	M	I	F,S
25	131	91	M	I	F,S
25	189	320	F	I	C,F,S
25	134	85	F	I	C,F,S
25	176	260	F	I	C,F,S
25	205	370	F	I	C
25	183	245	F	I	C,F,S
25	134	100	M	M	F,S
25	125	65	F	I	C
25	187	270	F	I	C
25	155	155	F	I	C,F,S
25	139	120	M	M	C
25	275	930	F	M	F,S
25	253	730	F	M	C,F
25	251	620	F	M	C,S
25	202	380	F	I	C
25	174	230	F	I	C
25	159	180	F	I	C,S
25	171	220	F	I	C,F,S
25	144	125	M	I	C,F
25	231	610	F	M	C,S
25	211	380	F	I	C
25	129	83	M	I	C
25	123	75	M	I	C,F
25	125	77	M	I	C,F,S
25	150	128	F	I	C,F
25	241	590	F	M	C,F
25	196	300	F	I	C,S
25	241	630	F	M	C,F
25	248	700	F	M	C
25	192	310	F	I	C
25	260	750	F	M	C,F,S
25	217	460	F	I	C,F
25	136	115	F	I	C,F
25	127	86	M	I	F
25	233	600	F	M	C,F,S
25	234	590	F	M	C,F
25	232	560	F	M	C,F,S
25	212	460	F	I	C,F,S
25	174	200	F	I	C,F
25	191	295	F	I	C
25	185	275	F	I	C
25	253	780	F	M	C,F,S
25	175	215	F	I	C
25	138	117	M	M	E
25	220	600	F	M	C

*I = immature; M = mature
†C = crustacean; F = fish; S = squid; E = empty; U = unidentified

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
25	208	500	F	M	E
25	168	190	F	I	
25	140	115	F	I	
25	120	66	F	I	
25	139	110	M	I	
25	153	155	F	I	
25	157	180	F	I	
25	140	118	F	I	
25	212	460	F	M	
25	231	520	F	M	
25	190	300	F	I	
25	262	840	F	M	
25	235	580	F	M	
25	226	540	F	M	
25	197	310	F	I	
25	218	410	F	M	
25	240	550	F	M	
25	232	560	F	M	
25	283	1050	F	M	
25	260	800	F	M	
25	267	900	F	M	
25	227	490	F	M	
25	232	560	F	M	
25	267	860	F	M	
25	224	530	F	M	
25	236	610	F	M	
25	127	85	M	I	
25	224	530	F	M	
25	207	400	F	I	
26	199	340	F	I	C
26	227	510	F	M	E
26	265	810	F	M	C
26	209	390	F	M	C,F
26	243	710	F	M	C,F,S
26	225	490	F	M	E
26	248	690	F	M	C,F
26	229	580	F	M	E
26	260	820	F	M	E
26	197	340	F	M	C
26	253	760	F	M	C,S
26	256	790	F	M	C,F,S
26	235	530	F	M	C,F
26	166	280	F	I	C,F
26	125	76	F	I	F,S
26	170	200	F	I	C,S
26	236	570	F	M	C
26	248	690	F	M	C,F
26	190	300	F	I	C,S
26	245	630	F	M	C,F
26	237	630	F	M	C,F

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
26	222	460	F	M	E
26	274	910	F	M	E
26	173	210	F	I	C,S
26	272	950	F	M	C,F,S
26	235	550	F	M	C,F
26	236	580	F	M	C,F,S
26	259	800	F	M	C,F,S
26	239	550	F	M	E
26	207	390	F	M	C
26	246	650	F	M	
26	244	620	F	M	
26	208	450	F	M	
26	274	920	F	M	
26	249	620	F	M	
26	143	120	M	M	
26	146	130	M	M	
26	218	430	F	M	
26	237	560	F	M	
26	252	700	F	M	
26	246	710	F	M	
26	234	510	F	M	
26	229	530	F	M	
26	239	600	F	M	
26	251	720	F	M	
26	204	370	F	M	
26	260	780	F	M	
26	233	650	F	M	
26	228	560	F	M	
26	219	490	F	M	
26	220	500	F	M	
26	257	710	F	M	
26	159	170	M	M	
26	149	170	M	M	
26	256	840	F	M	
26	201	390	F	M	
26	232	560	F	M	
26	239	610	F	M	
26	141	130	M	M	
26	225	300	F	M	
26	263	900	G	M	
26	243	620	F	M	
26	253	790	F	M	
26	217	510	F	M	
26	221	530	F	M	
26	222	520	F	M	
26	217	430	F	M	
26	210	410	F	M	
26	200	360	F	M	
26	188	270	F	M	
26	187	300	F	M	

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
26	158	160	F	I	
26	202	370	F	M	
26	138	115	M	M	
26	279	920	F	M	
26	238	520	F	M	
26	245	630	F	M	
26	234	590	F	M	
26	245	650	F	M	
26	272	860	F	M	
26	256	860	F	M	
26	244	630	F	M	
26	260	770	F	M	
26	265	840	F	M	
26	226	560	F	M	
26	163	190	F	I	
26	155	140	F	I	
27	263	730	F	M	E
27	252	700	F	M	E
27	248	620	F	M	S
27	207	380	F	M	E
27	247	640	F	M	E
27	231	500	F	I	F
27	253	740	F	M	S
27	232	590	F	M	S
27	253	710	F	M	E
27	275	950	F	M	F
27	158	130	M	M	C,S
27	255	670	F	M	E
27	259	740	F	M	F
27	279	960	F	M	C,S
27	242	630	F	M	S
27	201	370	F	M	S,U
27	184	170	F	I	E
27	204	370	F	M	S
27	269	840	F	M	F,S
27	185	240	M	M	C,F
27	179	190	M	I	E
27	171	200	M	M	U
27	202	360	F	M	F,S
27	246	630	F	M	C
27	215	380	F	I	E
27	259	790	F	M	F
27	277	950	F	M	C
27	23	880	F	M	S
27	273	900	F	M	F
27	264	770	F	M	C,F,S
27	252	730	F	M	
27	254	730	F	M	
27	225	520	F	M	
27	181	240	M	M	

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
27	220	470	F	M	
27	207	390	F	M	
27	246	680	F	M	
27	273	940	F	M	
27	231	550	F	M	
27	181	250	F	I	
27	252	730	F	M	
27	269	870	F	M	
27	219	480	F	M	
27	287	1020	F	M	
27	248	650	F	M	
27	253	650	F	M	
27	259	730	F	M	
27	258	740	F	M	
27	234	620	F	M	
27	249	600	F	I	
27	216	480	F	M	
27	223	470	F	M	
27	263	840	F	M	
27	198	350	F	M	
27	218	480	F	M	
27	233	690	F	M	
27	250	710	F	M	
27	263	740	F	M	
27	243	640	F	M	
27	236	390	F	M	
27	245	830	F	M	
27	225	480	F	M	
27	269	880	F	M	
27	275	890	F	M	
27	239	620	F	M	
27	259	790	F	M	
27	214	410	F	I	
27	239	610	F	M	
27	259	790	F	M	
27	218	460	F	M	
27	191	280	F	I	
27	182	220	F	I	
27	224	490	F	M	
27	176	230	M	M	
27	170	230	M	M	
27	154	170	M	M	
27	120	120	M	M	
27	151	165	M	I	
27	152	160	M	I	
27	147	143	M	M	
27	241	620	F	M	
27	268	820	F	M	
30	171	225	F	I	C
30	159	170	F	I	E

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
30	154	160	F	I	C
30	133	85	F	I	F
30	126	71	F	I	C
30	170	255	F	I	C,F
30	179	84	F	I	C
30	157	185	F	I	F
30	135	100	F	I	C,F
30	135	92	F	I	C,F
30	134	92	F	I	F
30	138	110	F	I	C,F
30	124	74	F	I	F
30	132	85	F	I	U
30	176	255	F	I	C,F,S
30	154	160	F	I	C,F,S
30	152	165	F	I	S
30	139	100	F	I	F
30	145	128	F	I	C,F
30	115	173	F	I	C,S
30	164	208	F	I	C,F,S
30	167	200	F	I	C,F
30	174	224	F	I	F
30	155	135	F	I	C,F,S
30	164	185	F	I	C,F
30	134	110	F	I	F
30	160	175	F	I	C,F,S
30	151	140	F	I	C,F
30	134	197	M	I	F
30	153	175	F	I	C,F,S
30	134	100	F	I	
30	130	75	F	I	
30	169	220	F	I	
30	129	84	F	I	
30	178	240	F	I	
30	196	350	F	I	
30	165	180	M	I	
30	132	190	F	I	
30	150	150	M	I	
30	177	230	M	M	
30	161	177	F	I	
30	170	206	F	I	
30	186	265	F	I	
30	179	248	F	I	
30	191	280	F	I	
30	135	100	F	I	
30	200	390	F	M	
30	151	150	F	I	
30	140	107	F	I	
30	152	143	F	I	
30	156	168	F	I	
30	125	89	M	I	

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
31	173	210	M	M	E
31	155	160	F	I	C
31	137	100	M	M	F
31	109	51	M	I	F
31	129	80	M	I	F
31	134	100	M	M	C,F,S
31	149	135	F	I	F
31	137	94	F	I	C,F
31	130	77	F	I	F
31	147	140	F	I	C
31	137	103	F	I	F,S
31	269	830	F	M	C,F
31	198	320	F	I	C,F,S
31	171	240	F	I	F
31	281	950	F	M	F,S
31	161	180	F	I	F,S
31	146	125	M	I	F
31	155	145	F	I	C
31	186	260	F	I	C,F
31	142	115	F	I	C
31	130	90	M	I	F
31	166	205	F	I	F,S
31	132	93	F	I	F
31	129	89	M	I	F
31	135	103	F	I	C
31	146	133	M	M	F,S
31	164	180	F	I	F
31	180	250	F	I	C,F
31	131	87	M	I	C,F
31	132	80	M	I	F
31	134	94	M	I	
31	128	74	F	I	
31	135	105	M	M	
31	163	190	F	I	
31	140	120	F	I	
31	128	97	M	I	
31	190	350	F	M	
31	174	330	F	I	
31	146	135	F	I	
31	141	120	M	M	
31	133	100	M	I	
31	206	410	F	M	
31	160	200	F	I	
31	164	190	M	M	
31	147	138	M	I	
31	139	105	F	I	
31	146	127	M	M	
31	129	88	M	I	
31	259	790	F	M	
31	254	680	F	M	

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
32	204	365	F	M	F,S
32	164	165	F	I	F
32	139	100	F	I	E
32	122	67	F	I	C,F,S
32	115	50	F	I	F
32	128	85	M	I	F
32	142	120	M	M	F
32	195	330	F	I	FF
32	228	500	F	M	F,S
32	253	750	F	M	C,F,S
32	145	125	F	I	F,S
32	193	310	F	I	E
32	121	57	M	I	F,S
32	138	100	F	I	F
32	113	48	F	I	F
32	138	105	M	I	F
32	135	94	M	M	C,F
32	125	78	M	I	S
32	183	245	F	I	E
32	170	210	F	I	C,F
32	175	210	F	I	E
32	152	150	F	I	F
32	167	195	F	I	E
32	141	110	F	I	F
32	188	275	F	I	E
32	136	100	F	I	E
32	142	120	F	I	F
32	136	100	F	I	F,S
32	261	740	F	M	E
32	235	580	F	M	F,S
32	169	205	F	I	
32	148	120	M	M	
32	114	40	M	I	
32	131	85	F	I	
32	135	88	F	I	
32	152	150	F	I	
36	134	108	M	M	F,S
36	123	69	F	I	F
36	133	96	F	I	F,S
36	143	135	M	M	C,F,S
36	236	610	F	I	F,S
36	171	223	M	M	E
36	176	245	M	M	F
36	212	430	F	M	F,S
36	244	680	F	M	F,S
36	169	195	M	M	F
36	160	178	M	M	F
36	155	150	M	M	F,S
36	150	150	F	I	F
36	144	118	F	I	F

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
36	149	120	M	M	F
36	151	135	F	I	F
36	166	210	F	I	C
36	161	185	F	I	C,F
36	163	175	F	I	F
36	143	120	M	M	F
36	192	225	F	I	F
36	166	190	F	I	F,S
36	160	165	F	I	F
36	162	175	F	I	C,S
36	147	125	F	I	F
36	144	120	M	M	F
36	177	277	F	I	C,S
36	193	329	F	I	S
36	151	157	F	I	E
36	141	146	F	I	E
36	150	140	F	I	
37	145	130	M	M	F
37	133	96	M	I	F,S
37	163	205	M	M	F
37	152	145	F	I	F
37	133	87	M	I	F
37	157	165	F	I	F
37	222	610	F	I	F,S
37	116	100	M	M	F
37	163	228	F	I	F
37	125	108	F	I	C
37	121	110	F	I	F
37	111	83	M	I	C
37	112	83	F	I	C,F
37	143	180	F	I	F,S
37	120	96	F	I	F
37	110	91	M	M	F,S
37	105	78	F	I	F,S
37	135	155	F	I	F
37	152	223	F	I	F,S
37	156	178	F	I	F,S
37	153	160	F	I	F,S
37	154	155	F	I	F
37	138	100	F	I	F
37	132	81	M	I	C,F
37	181	280	F	I	F,S
37	134	93	M	M	F
38	125	79	F	I	F
38	130	84	M	M	E
38	130	77	F	I	F
38	122	73	M	I	E
38	130	76	M	I	F
38	142	101	F	I	C
38	157	160	F	I	F

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
38	159	185	F	I	F,S
38	168	205	F	I	S
38	180	250	F	I	S
38	184	230	F	I	F
38	172	220	F	I	S
38	163	185	F	I	F,S
38	156	155	F	I	F
38	135	97	F	I	F
38	143	110	F	I	F
38	154	165	F	I	F
38	164	240	F	I	C,S
38	183	250	F	I	E
38	163	180	F	I	F
38	128	80	M	I	F,C
38	130	90	F	I	E
38	143	125	F	I	F
38	178	230	F	I	F
38	158	170	F	I	F
38	154	163	F	I	F
38	166	185	F	I	E
38	160	170	F	I	F
38	172	220	F	I	C,F
38	185	295	F	I	F,S
38	143	130	M	M	
38	133	90	F	I	
38	134	97	F	I	
38	201	363	F	M	
38	179	235	M	M	
38	167	195	F	I	
38	151	130	F	I	
38	138	97	F	I	
38	148	138	F	I	
38	152	130	F	I	
38	155	155	F	I	
38	150	135	F	I	
38	142	115	M	M	
38	151	150	F	I	
38	135	100	M	I	
38	143	130	F	I	
38	176	230	F	I	
38	190	270	F	I	
38	207	370	F	I	
38	138	107	F	I	
38	188	305	F	I	
38	139	115	F	I	
38	131	85	F	I	
38	165	195	F	I	
38	158	165	F	I	
38	170	200	F	I	
38	221	435	F	M	

Station No.	Mantle Length	Body Weight	Sex	Maturity*	Stomach Contents†
38	133	90	F	I	
38	176	240	F	I	
38	170	205	F	I	
38	184	280	F	I	
38	135	100	F	I	
38	136	96	F	I	
38	127	80	M	I	
38	175	225	F	I	
38	167	185	F	I	
38	163	170	F	I	